

IntechOpen

Contemporary Developments
and Perspectives in
International Health Security
Volume 1

*Edited by Stanislaw P. Stawicki,
Michael S. Firstenberg, Sagar C. Galwankar,
Ricardo Izurieta and Thomas Papadimos*



Contemporary Developments and Perspectives in International Health Security - Volume 1

*Edited by Stanislaw P. Stawicki,
Michael S. Firstenberg,
Sagar C. Galwankar, Ricardo Izurieta
and Thomas Papadimos*

Published in London, United Kingdom



IntechOpen





Supporting open minds since 2005



Contemporary Developments and Perspectives in International Health Security - Volume 1

<http://dx.doi.org/10.5772/intechopen.84766>

Edited by Stanislaw P. Stawicki, Michael S. Firstenberg, Sagar C. Galwankar, Ricardo Izurieta and Thomas Papadimos

Contributors

Mirza Abdul Aleem Baig, Aroem Naroeni, Budiman Bela, Davi F. Martins Junior, Martin Hushie, Rita Salifu, Iddrisu Seidu, Tanaya Sparkle, Debanshu Roy, Stanislaw P. Stawicki, Michael S. S Firstenberg, Thomas Papadimos, Scott Pappada, Michael Lyaker, James Papadimos, Andrew Casabianca, Andrew C. Miller, Abbas Khan, Nicholas Reis, James Cipolla, Bankim Bhatt, Christine Marchionni, Jordan Holter, Keith Conti, Shania Desai, Mendes Luciano, Ricardo Izurieta, Nicole K. Le, Manish Garg, Sona M. Garg, Bonnie Arquilla, Tamara Worlton, Sagar C. Galwankar, Sunil Raina, Harry L. Anderson III, Rebecca Jeanmonod, Donald Jeanmonod, Ijeoma Nnodim Opara, Kristiana Kaufmann, Juan A. Asensio, Sophia Ziad

© The Editor(s) and the Author(s) 2021

The rights of the editor(s) and the author(s) have been asserted in accordance with the Copyright, Designs and Patents Act 1988. All rights to the book as a whole are reserved by INTECHOPEN LIMITED. The book as a whole (compilation) cannot be reproduced, distributed or used for commercial or non-commercial purposes without INTECHOPEN LIMITED's written permission. Enquiries concerning the use of the book should be directed to INTECHOPEN LIMITED rights and permissions department (permissions@intechopen.com).

Violations are liable to prosecution under the governing Copyright Law.



Individual chapters of this publication are distributed under the terms of the Creative Commons Attribution 3.0 Unported License which permits commercial use, distribution and reproduction of the individual chapters, provided the original author(s) and source publication are appropriately acknowledged. If so indicated, certain images may not be included under the Creative Commons license. In such cases users will need to obtain permission from the license holder to reproduce the material. More details and guidelines concerning content reuse and adaptation can be found at <http://www.intechopen.com/copyright-policy.html>.

Notice

Statements and opinions expressed in the chapters are these of the individual contributors and not necessarily those of the editors or publisher. No responsibility is accepted for the accuracy of information contained in the published chapters. The publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained in the book.

First published in London, United Kingdom, 2021 by IntechOpen

IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 5 Princes Gate Court, London, SW7 2QJ, United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Contemporary Developments and Perspectives in International Health Security - Volume 1

Edited by Stanislaw P. Stawicki, Michael S. Firstenberg, Sagar C. Galwankar, Ricardo Izurieta and Thomas Papadimos

p. cm.

Print ISBN 978-1-83880-129-8

Online ISBN 978-1-83880-130-4

eBook (PDF) ISBN 978-1-83962-928-0

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

5,100+

Open access books available

127,000+

International authors and editors

145M+

Downloads

156

Countries delivered to

Our authors are among the
Top 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Meet the editors



Stanislaw P. Stawicki, MD, MBA, FACS, FAIM, is Chair of the Department of Research of Innovation, St. Luke's University Health Network, Bethlehem, Pennsylvania, and Professor of Surgery at Temple University School of Medicine. Dr. Stawicki has edited numerous books and book series on the topics of clinical research, medical education, medical leadership, patient safety, health security, and various other subjects. He is a member of multiple editorial boards and has co-authored more than 650 publications. He served as the inaugural president of the American College of Academic International Medicine (ACAIM) and directed its Taskforce on International Health Security. He has given a multitude of scientific presentations around the globe and is board certified in general surgery, surgical critical care, and neurocritical care.



Michael S Firstenberg, MD, FACC, FAIM, is a board-certified thoracic surgeon practicing adult cardiac surgery at The Medical Center of Aurora, Colorado, where he serves as Chief of Cardiothoracic and Vascular Surgery. He currently holds adjunct appointments in the Colleges of Medicine and Graduate Studies at Northeast Ohio Medical University and serves on the teaching faculty at Rocky Vista University, Colorado. He attended Case Western Reserve University Medical School, received his general surgery training at university hospitals in Cleveland, and completed a fellowship in thoracic surgery at Ohio State University. He also obtained advanced training in heart failure surgical therapies at the Cleveland Clinic. He is an active member of the Society of Thoracic Surgeons (STS), American Association of Thoracic Surgeons (AATS), American College of Cardiology (ACC), and American College of Academic International Medicine (ACAIM), the latter for which he is a founding fellow and current president-elect. He currently serves as chairman of the American College of Cardiology Credentialing and Member Services Committee as well as an active member on several other national society committees. He is the author of more than 200 peer-reviewed manuscripts, abstracts, and book chapters. He has edited several textbooks on subjects such as medical leadership, patient safety, endocarditis, and extra-corporeal membrane oxygenation, all of which include topics that he has lectured on worldwide.



Ricardo Izurieta, MD, DrPH, MPH, is Professor and Director of Global Communicable Diseases at College of Public Health and director of the Public Health Scholar Concentration at Morsani College of Medicine, University of South Florida, Tampa. Dr. Izurieta received his MD from the Central University of Ecuador and carried out his postdoctoral training in Public Health and Tropical Infectious Diseases at the University of Alabama at Birmingham, Emory University, Atlanta, and Universidad Cayetano Heredia, Peru. In 1991, he faced the cholera epidemic that spread through Latin American countries as National Director of the Cholera Control Program in the Ministry of Public Health of Ecuador. In 1997, he was appointed Chief of the Department of Epidemiology and Director of the Vaccine Center of the Armed Forces of Ecuador.

During his studies, he has been a USAID Thomas Jefferson Fellow, a PAHO Research Fellow, an ORISE/CDC Fellow, a Gorgas Memorial Institute Fellow, and a FUNDA-CYT Fellow. In 2003, Dr. Izurieta was elected vice president of the Gorgas Memorial Institute of Tropical and Preventive Medicine and currently he is its Latin American Liaison. He has been a panel reviewer for the National Institutes of Health (NIH), Centers for Disease Control and Prevention (CDC), National Science Foundation (NSF), and Wellcome Trust. He also served on the American College of Academic International Medicine (ACAIM) Taskforce on International Health Security and as a consultant for the United Nations Global Water Pathogens Project as well as for the United Kingdom and the Brazilian Academies of Sciences.



Sagar C. Galwankar, MBBS, DNB, MPH, FAAEM, FAIM, graduated from Pune University, India, as a MBBS Allopathic Physician in 1995. He is residency trained and board certified in internal medicine and emergency medicine in India and the United States, respectively. He is a prestigious fellow of the Royal College of Physicians, UK, and completed a MPH with additional training in Business Management in the United States. His academic experience over the last two decades includes consistent achievements and innovative strategies that have led to the creation of organizations, publication of landmark papers, and commendation with prestigious citations and honors for his works that have impacted academic medicine globally. He has played a defining role in founding and building internationally recognized interdisciplinary indexed journals. He is the CEO of the INDUSEM Health and Medicine Collaborative and heads the World Academic Council of Emergency Medicine (WACEM). Additionally, he serves as the Global Executive Director for the American College of Academic International Medicine (ACAIM). He is the Director for Research in Emergency Medicine at Florida State University (FSU) and serves as a core faculty for the FSU Emergency Medicine Residency Program, at Sarasota Memorial Hospital in Florida.



Thomas J. Papadimos, MD, MPH, FCCM, FAIM, is Professor of Anesthesiology and Director, Anesthesiology Clinical Research Fellowship at the Ohio State University Wexner Medical Center, Columbus, Ohio. Dr. Papadimos co-authored hundreds of high-impact publications and co-edited several books on patient safety, leadership, medical education, and ethics. He also serves on several prestigious editorial boards. His multiple leadership roles include active involvement in undergraduate, postgraduate, and graduate medical education, as well as the vice presidency of the American College of Academic International Medicine (ACAIM). He is among the top US leaders in immersive medical simulation. He is a member of the Ohio State University Center for Ethics and Human Values and was awarded the 2020–2021 Fulbright Scholarship.

Contents

Foreword	XIII
Preface	XV
Chapter 1	1
Introductory Chapter: International Health Security Expanded and Re-Defined <i>by Stanislaw P. Stawicki, Thomas J. Papadimos, Sagar Galwankar, Ricardo Izurieta and Michael S. Firstenberg</i>	
Chapter 2	13
International Health Security: A Summative Assessment by ACAIM Consensus Group <i>by Nicole K. Le, Manish Garg, Ricardo Izurieta, Sona M. Garg, Thomas J. Papadimos, Bonnie Arquilla, Andrew C. Miller, Abbas M. Khan, Tamara Worlton, Michael S. Firstenberg, Sagar Galwankar, Sunil Raina, Harry L. Anderson III, Rebecca Jeanmonod, Donald Jeanmonod, Ijeoma Nnodim Opara, Kristiana Kaufmann, Juan A. Asensio and Stanislaw P. Stawicki</i>	
Chapter 3	47
The Impact of Systems of Care on International Health Security <i>by Nicholas Reis and James Cipolla</i>	
Chapter 4	69
Ransomware and Academic International Medicine <i>by Andrew C. Miller, Abbas M. Khan and Sophia Ziad</i>	
Chapter 5	83
The Evolving Interplay between Social Media and International Health Security: A Point of View <i>by Keith Conti, Shanaya Desai, Stanislaw P. Stawicki and Thomas J. Papadimos</i>	
Chapter 6	105
Health Security and the Refugee Crisis in Greece: The Refugee Perspective <i>by Thomas Papadimos, Scott Pappada, Michael Lyaker, James Papadimos and Andrew Casabianca</i>	
Chapter 7	125
A Moral Perspective on Refugee Healthcare <i>by Tanaya Sparkle and Debanshu Roy</i>	

Chapter 8	141
Strengthening International Health Security by Embedding the Role of Civil Society Organizations in National Health Systems: Lessons from the 2014–2016 West Africa Ebola Response <i>by Martin Hushie, Rita Suhuyini Salifu and Iddrisu Seidu</i>	
Chapter 9	159
The Importance of Reduction in the Registry of Deaths to Ill-Defined Causes and Their Impact on Mortality Profile: The Brazilian Experience and Its Implications to International Health Security <i>by Davi Félix Martins Junior</i>	
Chapter 10	169
The Relationship of Adulthood Chronic Disease and Adverse Childhood Experiences (ACEs): Implications Regarding Prevention and Promotion in International Health <i>by Jordan Holter, Christine Marchionni and Bankim Bhatt</i>	
Chapter 11	181
Nurturing Responsible Future Generation of Scientists: Focus on Maintaining International Health Security Competency <i>by Aroem Naroeni and Budiman Bela</i>	
Chapter 12	195
mHealth-Based Microfluidic Lab-on-a-Chip for International Health Security <i>by Mirza Abdul Aleem Baig</i>	
Chapter 13	211
Beyond Health and Safety at Work: Reflections on Biopolitics in Occupational Health as an Important Component of International Health Security <i>by Mendes Luciano</i>	

Foreword

It is with great honor that I have had the privilege of traveling and lecturing with many of the editors of this novel Volume 1 of Contemporary Developments and Perspectives in International Health Security. As I have traveled the world and visited every continent, it is striking to see the lives of ordinary citizens around the world and how different basic health and living standards (security) are based on where one lives.

I do remember one time in New Delhi, India, where a cab driver lamented at the conditions of the roads in India and told me of his dream of visiting America. He showed me a video of his relative in the United States, driving down a highway with clearly marked lanes, much more orderly than we were experiencing in our drive through this massive and beautiful Indian city. The paving of a dirt road not only expands the possibilities to travel more efficiently but also extends to health, culture, and community. The international experience highlights the interwoven aspects of everyday life that can impact a person's ability to live and survive based on the culture and components of a secure civilized society.

A threat to one can be a threat to all. Death, disease, famine, and pestilence. The reality of the coronavirus disease 2019 (COVID-19) created a ripple in our world that will impact humans for years, if not decades, to come. The broadened definition of International Health Security (IHS) is the right idea at the right time. The focus on HIS as that is based on individuals who participate in their community, as well as the security of physical, emotional and spiritual needs, is the link to foster dialogue and discovery well into the future.

In 2020 we find ourselves in the midst of one of the most information-dense times in human history. As medical knowledge doubles every few months, keeping up makes the organization of this information and best evidence a necessity across the world. The manifestation of Moore's Law, the metronome of digital advancements as a function of silica chips doubling the capacity and shrinking in size by half every 18–24 months, is our next generation smartphone universe and access to massive sets of information, right in the palm of one's hand. With the thought of Elon Musk's Starlink, the satellite connectivity of every continent and possibly every person will be the realization of a truly global human network. Gordon Moore, the founder of Intel Corporation, described the phenomenon that has seen computer processing progress to artificial intelligence and machine learning. The mathematics behind these amazing advancements and more in some economically resourced zip codes of the world is astonishing. As the world transitions from analog to the digital transformation of knowledge, power, and truth amidst societies, communities, and health systems, the next step is to codify the language used to describe our new world with the new challenges we encounter every day.

Each person is the first line in an onslaught of massive information and even more disinformation. What is the truth? What is logic? What is the spin? What does the evidence say? What would the scientist do? Now, what would the politicians do? The world and information availability is not the problem; it is the critical analysis

of this information and separating the wheat from the chaff. When should I evacuate with this incoming storm? Am I at risk for this new infectious disease? Signal-to-noise ratios depend on the individual and cohort goals of you and your “family” social group to interpret information and balance it with one’s experience and insight. In some cultures the fight is for equal opportunities. The future challenge is equalizing outcomes.

It is our health. Do we control our health information? Is it in a form that is portable, secure, and able to be updated as new information emerges? Can information help us meet and achieve our own hierarchy of needs? The future of HIS will be determined by how communities try to implement best practices for all. The equality of all with freedom, liberty, and justice in America is much different than that of the 194 other countries and sovereign nations.

IHS is the thread to this earthen security blanket. The idea of IHS is innovation. This book is a testament to the importance of seeing how the global security of the individual is transformed into IHS. We are more interconnected than we have ever been. The future is the understanding of this reality through further innovation and creativity. This is why this book is so important. The topics to focus on will be much different post COVID. Telemedicine was a great leap forward, while lockdowns were a significant step back. The future is the innovation of ideas such as IHS, and the path forward is feasible for the destiny of an evolved humanity.

The infrastructure of culture and access to health care, emergency care, and other necessary services is much different depending on where one lives. According to 2008 data from the World Bank, 80 percent of the world’s population lives on less than \$10 dollars a day. There are billions of living in poverty. The wealthiest 20 percent are creating 75 percent of the world’s income, while the less fortunate 40 percent are able to contribute only 5 percent of the world’s income. Economic disparity, food “deserts,” and energy insecurity stagnate the standards of living in some areas across generations, even in high-income nations. Health disparities exist in every country, yet in many nations, these are closely related to socioeconomic status, ethnicity, immigration status, and being a refugee.

A global pandemic resulted in the need to have thoughtful, evidence-based strategies in response to the many threats to human health. Living a healthy life that is productive and full should be an option for every human, but that is sadly not the case. Growing up in America is a much different experience than growing up in Delhi. Yet for whatever class, caste, or socioeconomic condition one finds themselves in, injuries and infections persist in everyday life, without exceptions. The coronavirus is the most recent threat to IHS. Secure patient data, artificial intelligence, and genetically modified organisms are just some of the many modern challenges faced by individuals worldwide. How does the global network of humanity respond to twenty-first century threats to IHS? How should we prioritize education and knowledge, scientific curiosity and skepticism, thoughtful deliberation and teamwork? IHS recognizes that each individual exists with humanity and free will, yet many persons do not have the socioeconomic environment conducive to learning, growing, and securing a humane life with basic elements of health security.

The world is more interconnected than ever before and when supply chains, essential minerals, and medical supplies were transported seamlessly pre COVID and distributed in an efficient way; with COVID, the world is a much different place. This is why the topic of IHS is more important than ever. The health of every

person has a connectedness of purpose and happenstance related to each other in multiple ways. Moving forward, the prioritization of IHS will be important for generations to come as modern humans survive and thrive in a world of social media, information overload, and cyber- and in-person threats to health. This volume and subsequent textbooks on IHS are resources to help solve the many challenges that confront humanity in our modern times. The old adage of Pandora's Box had the ills of the world being released onto humanity, yet at the bottom of that "box" was hope. This book stands out as a hope of collaboration between multiple experts to confront threats to health.

Global participation in this knowledge economy will need entrepreneurs and innovators from across the world. To solve modern problems, we need modern solutions from a wide array of scientists and persons with experience and desire to help affect change. The authors of this book are dedicated to contributing to that change with much-needed attention to the importance of the current moment and the language needed to solve these problems around IHS. Historians will mark 2020 as a turning point, and this book is the first to conceptualize humanity as the common denominator in IHS.

Respectfully,

David P. Bahner MD
Ultrasound Division Chief,
Professor,
Department of Emergency Medicine,
The Ohio State University,
Columbus, Ohio, United States

Preface

International health security (IHS) is a broad and highly heterogeneous area. Within this general context, IHS encompasses subdomains that potentially influence (and more specifically endanger) the well-being and wellness of humans. The general umbrella of IHS includes, but is not limited to, natural disasters, emerging infectious diseases (EID) and pandemics, social determinants of health, systemic racism and discrimination, rapid urbanization, population growth, environmental matters, civilian violence, warfare and terrorism, inappropriate use of antibiotics, and the abuse of social media (SM). The need for this expanded definition of health security stems from the realization that topics such as EID; food, water, and pharmaceutical supply chain safety; medical and health information cybersecurity; and bioterrorism, although important within the overall realm of health security, are not only able to actively modulate the wellness and health of human populations, but also are likely do so in a synergistic fashion.

The editors of this book believe that the broadly defined IHS inherently encompasses the plurality of concepts that include “public health,” “global health security,” and “planetary health.” At the same time, it is important to ensure that the overall context of IHS implementation maintains compatibility with the modern concept of the world constituting a collection of independent countries and states that operate within a well-defined set of international conventions, organizations, and frameworks. This is the foundation and the starting point of our approach, upon which we expand and build our multi-pronged argument for the more broadly defined and understood IHS.

This inaugural tome of our multi-volume collection, *Contemporary Developments and Perspectives in International Health Security*, introduces many of the topics directly relevant to modern IHS theory and practice. Starting with a summative assessment by the IHS Working Group of the American College of Academic International Medicine, the book then moves on to discuss a variety of contemporary topics such as refugee crises, cybersecurity, SM, big data analytics, scientist training, and point-of-care diagnostics. Unique contributions to Volume 1 include a compendium by Reis and Cipolla on the impact of organized systems of care on IHS, focusing on the tremendous value of such systems to our overall healthcare security landscape.

Of importance, a new set of insidious threats to health security emerged with the widespread adoption of the Internet and various SM platforms. These important topics are covered in two excellent chapters by Miller, et al., and Conti, et al. The first of the two chapters discusses an all-too-common phenomenon of ransomware that increasingly plagues our healthcare systems and contributes to significant risk of critical data loss. The second chapter discusses both the benefits and the dangers of modern SM technology, including some of the proposed approaches to mitigate the negative aspects. Of special concern is the emerging evidence regarding the very design of SM platforms, with the key element of the business model being the ability to fractionate people into self-reinforcing, opinion-based camps.

The book then shifts focus to very important and emerging topics of the refugee crisis and refugee healthcare. Attributable to a confluence of multiple factors,

including armed conflict, planetary climate change, economic uncertainty, and food security, the percentage of the human population considered to be refugees is increasing. Spearheaded by Papadimos, et al., and Sparkle, et al., this section discusses key concepts related to human, economic, and healthcare aspects of the ongoing global refugee crisis, including dilemmas created for governments and refugees regarding manipulation, displacement, human rights, sexual exploitation, and the need for robust legal options and remedies.

Within the greater context of this inaugural volume, pandemics are addressed as humankind's socio-political constructs that, at some point in history, either require or outright force a major paradigm shift. Such is the case with the current coronavirus disease 2019 (COVID-19) pandemic. The book concludes with both unique and diverse chapters on the role of civil society organizations in national health systems during the 2014–2016 Ebola outbreak by Hushie, et al.; the importance of big data and health registries within the overall IHS framework by Martins, Jr.; an insightful perspective on nurturing responsible future generations of scientists by Naroeni, et al.; an exploration of a relationship between adverse childhood experiences and adult chronic disease by Bhatt, et al.; a compendium on biopolitics in occupational health by Mendes, et al.; and, finally, a contribution that discusses lab-on-a-chip, point-of-care approaches within the international public health security context by Baig, et al.

With this unique and paradigm-changing content, we hope that this inaugural volume of Contemporary Developments and Perspectives in International Health Security will provide a solid foundation for future installments of this important and relevant book series. We hope that the foundation created by this editorial team will provide a solid springboard for an insightful and captivating second installment of the current book series, complete with a robust discussion of the COVID-19 pandemic and related topics.

Stanislaw P. Stawicki

St. Luke's University Health Network,
USA

Michael S. Firstenberg

The Medical Center of Aurora,
USA

Ricardo Izurieta

University of South Florida,
USA

Sagar C. Galwankar

Florida State University,
USA

Thomas Papadimos

The Ohio State Wexner Medical Center,
USA

Introductory Chapter: International Health Security Expanded and Re-Defined

*Stanislaw P. Stawicki, Thomas J. Papadimos,
Sagar Galwankar, Ricardo Izurieta
and Michael S. Firstenberg*

1. Background

International health security (IHS) is a complex and highly heterogeneous area under the broader umbrella of health sciences. Within that general context, IHS encompasses all domains that potentially influence (and more specifically - potentially endanger) the well-being of human health and wellness, from natural disasters to outbreaks and pandemics, including rapid urbanization, population growth, various environmental matters, critical supply chain vulnerabilities, misuse of antibiotics leading to unpredictable microbial resistance patterns, and even social media (SM) misinformation. The need for this expanded definition of health security came about with the realization that topics such as emerging infectious diseases (EID), food, water, and pharmaceutical supply chain safety, medical and health information cybersecurity, and bioterrorism – although clearly dominant factors within the overall realm of health security – constitute only a small proportion of forces able to actively modulate the wellness and health of human populations [1–7].

2. Why did we embark on this project?

There are ample resources for IHS experts, and many available literature sources are characterized by very high content quality. Why then, one might ask, embark on another book project on the topic? There are several important reasons. The first, and most relevant reason, is the narrow focus on the previously published scholarly literature on this increasingly complex subject. Today's IHS is a much broader and diverse discipline, with highly nuanced and rapidly evolving new areas and subdomains (**Table 1**). Some authorities on this topic even go as far as referring to Planetary Health as the next conceptual development [8, 9]. The authors and Editors of this collection of chapters believe that the broadly defined IHS inherently encompasses the plurality of concepts that include “public health,” “global health security,” and “planetary health” while ensuring that the overall context of its implementation maintains the compatibility with the modern understanding of the world constituting a collection of independent countries and states that operate within a well-defined set of international conventions, organizations and frameworks [10–12]. By covering new topics and providing varied solutions and

Access to health care
Biological and chemical warfare
Chronic health conditions
Emerging infectious diseases
Food/agricultural security
Globalization, including trade and travel
Health informatics/cyber health
Industrialization/robotization and related topics
Natural disasters, including volcanic/tectonic activity and natural fires
Nuclear security, both civilian and military
Pharmaceutical production and supply chains
Environmental pollution water/air/soil
Planetary changes/global warming/invasive species
Social determinants of health
Social media platforms
Systemic racism and other forms of discrimination
Terrorism/bioterrorism and related topics

Table 1.
New areas and subdomains included within the redefined and expanded International Health Security (IHS) paradigm.

approaches on rapidly emerging infectious, social, environmental, and biopolitical dilemmas, etc., the authors hope to enlighten and energize readers to become more aware and active in matters related to health security at local, regional, national, international, as well as global scales.

3. Expanding the definition and the scope of health security

The traditional definition of what was generally known as “global health security” or GHS is somewhat limited, including primarily bioterrorism and EIDs [13]. In essence, and in a much broader sense, we are dealing with human security. The world is interdependent and we must manage our activities jointly, find common ground, and together deal with the threats with which we are confronted. As Ebola Virus, Zika Virus, and Coronavirus Disease 2019 (COVID-19) have demonstrated, a threat to one (person, region, country, continent) can easily evolve into a threat to all [14–16]. Herein we present facts, experiences and perspectives regarding important currents that affect all societies. Fundamentally, the Editors would like the readers to recognize health security vulnerabilities that they may have not previously considered and to realize opportunities that the readers themselves can create or support across their own communities, countries, and continents [17]. The current book expands on the more traditional and restricted view of IHS to incorporate new and important components of climate change, global health, cyber security, social determinants of health, technology/information management, and several other closely related areas.

4. Bridging health security and human sustainability

Health security requires a “360-degree approach” because health problems tend to have a “360-degree impact” and therefore the solutions also have to address various associated facets and intricacies in a comprehensive and inclusive fashion. The current COVID-19 pandemic exposed vulnerabilities in various critical supply chains, including those involving things we all take for granted, such as basic medications, home oxygen availability, personal protective equipment (PPE)

and the tremendous speed of evolving science that made us all vulnerable to both misunderstanding and misinformation [18]. COVID-19 also demonstrated that the term “health security” is inextricably tied to how we as humans can effectively respond to such a tremendous global challenge [19, 20].

Among challenges to sustainability, we must recognize the presence of “response exhaustion” or a phenomenon where the responders’ ability to address the ongoing health crisis at a population level becomes ineffective due to the overwhelming nature of the task at hand, especially when dealing with long and protracted time-frames that require sustained, high-intensity effort. Excellent planning, both conceptual and logistical, is required to mitigate such “response exhaustion.” Prematurely “letting our guard down” predisposes all to significant downstream effects of a long-lasting and dangerous threat – much like not adequately extinguishing a campfire only to realize that it becomes the source for a uncontrollable forest fire. Securing health is an effort which definitely translates to sustaining health and thus human well-being, and the loss of either leads to loss of the other.

The current collection of chapters takes on a comprehensive and integrative approach toward a truly global problem, highlighting the interconnectedness of the various components of the proposed IHS framework (**Table 1**). For example, a natural disaster, despite best preparatory efforts, may cause significant disruptions across multiple IHS domains, resulting not only in the destruction of essential infrastructure, but also directly and indirectly affecting human health within the affected region [21], as well as various potential downstream effects on other areas such as food security (e.g., if the disaster-stricken country is a major agricultural exporter). Humans have learned to design plans and take proactive steps to mitigate damage and save lives. However, such plans and steps must also be kept in the context of the reality of the constantly evolving geopolitical and socio-economic global landscape. In the highly interconnected world, events have the potential to evolve as rapidly as a click of a computer mouse button, or perhaps one’s ability to enter a commercial airliner on one continent and arrive on another within half-a-day [22, 23]. Be it “health security” or “cyber security,” sustainability depends on our expanded definition and understanding of “comprehensive health security”.

5. Integrative synthesis and synergy creation

As we embark on the journey across the much more diverse and heterogeneous landscape of IHS, both reimagined and redesigned, each chapter introduces a new and unique perspective on interrelated topics that blend into a comprehensive repository of synergistic experiences, knowledge, and approaches. The ultimate goal is to create an authoritative, open access source of the most important insights available to-date within the expanded IHS domain. The current collection is therefore intended to include discussions on some of the most pressing topics within the broader context of public health and health security. Starting with a summative assessment by the IHS Working Group of the American College of Academic International Medicine, the discussion then moves on to incorporate a variety of contemporary topics such as refugee crises, cyber security, social media, big data analytics, scientist training, and point-of-care diagnostics. Also important to the overall IHS discussion, the authors touch upon the importance and impact of organized systems of care on health security, focusing on the tremendous value of such systems to human wellness and the continuous focus on care quality and improving clinical outcomes [24–28].

More recently, a new set of insidious threats to health security emerged with the advent of Internet and social media (SM). This general theme includes the now all-too-common phenomenon of ransomware that increasingly plagues our healthcare systems and various critical supply chain components. In addition, it is important to emphasize the benefits, while also highlighting the dangers of modern SM technology, including some of the approaches to mitigate the negative aspects. Of special concern is the emerging evidence regarding the very design of SM platforms, with key element of the business model being the ability to fractionate individuals and groups into self-reinforcing, opinion-based camps [1, 29–32].

We would be remiss not to discuss herein the critically important and emerging topics of refugee crisis and refugee healthcare. Relevant to this context, careful considerations must be given to human, economic, and healthcare aspects of the ongoing global refugee crisis, including dilemmas created for governments and refugees regarding manipulation, displacement, rights, sexual exploitation, and the need for legal options. Serious global efforts must be made on behalf of the refugees by the host governments to provide the necessary resources to ensure the well-being of the 15 million+ refugees around the world [33], along with the 214 million international migrants and 740 million internal migrants [34]. Comprehensive examinations of the problem must also consider refugees in relation to the political, social and moral perspectives of the topic.

Especially relevant in the context of the current novel coronavirus (SARS-CoV-2) crisis, pandemics and plagues must be addressed as mankind's socio-political constructs that – at some point in the history – either require or outright force a major paradigm shift. Historically, the known plagues have decimated the young children and the elderly; but emerging pathogens (inclusive of SARS-CoV-2) have changed the paradigm sparing the young and primarily preying on those over 50 years of age [18, 35, 36]. And it is precisely such low-frequency, high-impact, largely unexpected events that produce generational fear, collective memory, and subsequent durable change among populations [18, 37]. In addition, as has been seen during the COVID-19 pandemic, such changes can occur very quickly regardless of whether communities, industry, governments, or society are prepared or able to efficiently or peacefully adapt. Currently, the world is reacting to the reality of an ongoing crisis of multi-generational proportions, with limited means to remedy or mitigate the impact. The evidence and lessons learned to-date from the COVID-19 pandemic indicate that the “Pasteurian paradigm” – which establishes that health security is primarily determined by a singular factor: the pathogen – has to be abandoned. Instead, the evidence seems to show that the health-disease continuum is considerably more likely to be affected by a plethora of political, social, economic, environmental and individual factors [18]. Therefore, when forming a more mature understanding of the construction of a more complex causal framework, the world will need to respond with a more holistic approach addressing social inequities, environmental pollution, protecting biodiversity, strengthening local health systems, prioritizing public and preventive health interventions, reducing non-communicable co-morbidities and promoting healthy behaviors [38]. Within the expanded IHS framework, the repose to the current pandemic has been a kind of one-size-fits-all public health policy without a strategic assessment of the local and regional situation. The undercapacity of our existing surveillance and control systems has forced local governments to “copy and paste” control strategies from abroad [18, 38]. Also, in the last few decades, there has been a dramatic disinvestment in the area of public health. Moreover, the concept that investment in the workforce's health positively impacts productivity seems to have been abandoned. Nevertheless, the immense costs for the global economy of the COVID-19 pandemic have changed this paradigm and forced stakeholders to re-emphasize the need for robust public health funding. As a matter of fact, no other pandemic has affected the U.S. and the global economy with such historical precedent [39, 40], at least in absolute terms.

No discussion of International Health Security would be complete without touching upon unique and diverse roles of civil society organizations in national health systems during the 2014–2016 Ebola outbreak; the importance of big data and health registries within the overall IHS framework; an insight into nurturing responsible future generations of scientist; an exploration of a relationship between adverse childhood experiences and adult chronic disease; a compendium on biopolitics in occupational health; and finally a mention of lab-on-a-chip, point-of-care approaches within the international public health security context [41–45].

6. Future trends

It is important to recognize that the field of IHS continues to evolve dynamically, and that its subdomains are in constant flux (**Figure 1**). For example, it is now recognized that systemic racism – as well as other forms of systemic discrimination – constitutes a prominent threat to health security [21, 46–48], and that socioeconomic inequity plays an important role in the overall existing global health imbalance [47–49]. These critically important issues have only recently been recognized as essential elements of health security, with implications felt across a variety of settings and dimensions.

The IHS community must stand in solidarity, and act swiftly, when tragic events – such as large industrial explosions or toxic chemical releases – recur at an unacceptably high frequency. For example, the recent explosions in Beirut resulted in great loss of life, many wounded, and massive destruction of property and critical infrastructure [50]. Yet the pattern is eerily similar to previous incidents, both characterized by massive scale explosions, preventable loss of life, and tremendous property damage. In this context, what should be major global health security lessons were minimized to “local problems,” leading to lost opportunities to save lives. For example, rewinding back to 2015, a series of industrial chemical explosions killed 173 people, wounded 798, and created billions of dollars in lost property [51]. In many cases, significant proportion of those who lost their lives were first

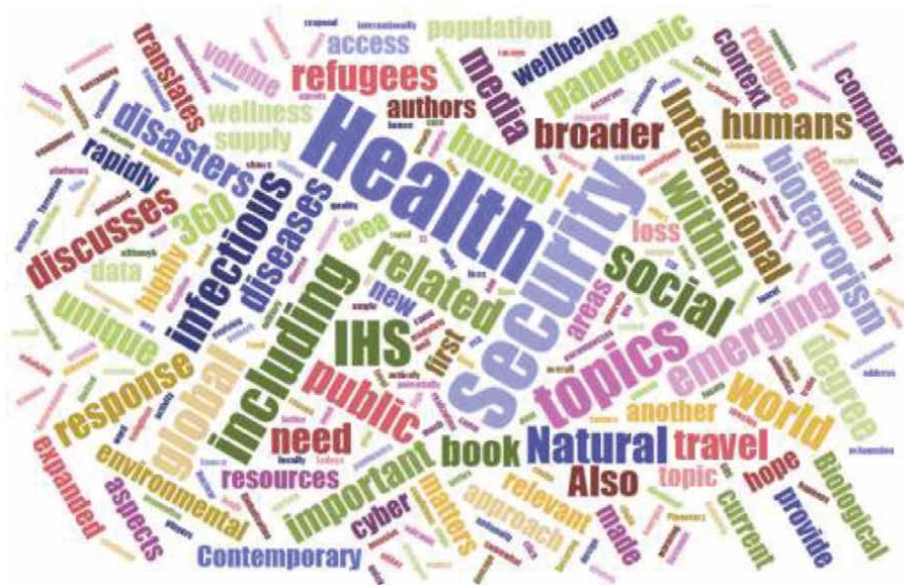


Figure 1. Composite word cloud depicting some of the keywords and dominant concepts in International Health Security.

responders [50, 51]. The world needs to learn from these catastrophic industrial events and strive to ensure that dangerous chemicals are not allowed near large population centers in quantities sufficient to cause mass destruction and loss of life.

Likewise, there is growing recognition of the profound effects brought about by the early manifestations of climate change, such as the realization that sea-level rise is here to stay, and that phenomena including invasive species, zoonotic-to-human disease transmission, and regional hunger due to disruption in food supplies, are not only real but also likely to worsen in the foreseeable future [21]. The increasingly apparent frequency of both natural forest fires and wind disasters are among additional, more obvious manifestations of the ongoing planetary change [21, 52]. The immediate and evolving risks are only now slowly coming into focus with an impact and magnitude that will only be understood over time. What is becoming more obvious is the potential global implications of what might have been previously minor events in remote places of the world. While it is well-established that certain local events may have geo-political implications on local, regional, and often global economies (i.e., a local act of terrorism in an oil-rich country potentially impacting the complex economics of oil), it is quickly becoming clear that such events also create significant impact on global health [53, 54].

In another example, supply chain factors are beginning to endanger the availability of entire classes of life-saving pharmaceuticals [55]. Within this subdomain, relatively recent concerns of potentially carcinogenic impurities in commonly prescribed antihypertensive medications made international headlines [56], but unfortunately were pushed to the back pages with an evolving – and at the time, highly controversial, politically charged, and poorly understood novel viral pandemic [36, 57]. Nevertheless, the concept of the “butterfly effect” – especially as applied to international health security – becomes, tragically, easier to understand [58]. Smaller events, in themselves, potential perceived as trivial at the time, have the potential to slowly evolve into events with global catastrophic implications [18]. Such events, superimposed with fluctuations in political agendas, economic disparities, budgetary constraints, and a perceived abandonment of the mistakes of the past and government safety nets unfortunately might become more common. The growing role of SM in giving credence to conspiracy theories, radicalism, and so called “fake news” only compounds the problems especially with regards to leaders being able to establish creditable action plans to manage such threats [29, 31]. As the population of the world grows to potentially unsustainable sizes [59], combined with concerns of climate change, simmering socio-economic and political conflicts will all play a role in the growing concerns for the “safety” and sustainability of humanity. Such events, must be taken seriously at all levels – but there are no easy solutions to the problems that frequently start on a small and often difficult-to-notice scale.

7. Summary and conclusion

The expanded and redefined scope of International Health Security provides a unique opportunity for the public health community to embrace a more holistic approach to an area that was traditionally much more narrow in scope. As we tackle one of the greatest challenges to IHS in recent decades – the novel coronavirus 2019 (COVID-19) pandemic – it becomes increasingly important to shift our focus to a more global, yet significantly more granular, perspective on IHS threats and emergencies. We hope that the foundation created by this Editorial team will provide a solid springboard for an insightful and captivating discussion in this rapidly developing and important area of academic medicine and public health.

Author details

Stanislaw P. Stawicki^{1*}, Thomas J. Papadimos², Sagar Galwankar³, Ricardo Izurieta⁴ and Michael S. Firstenberg⁵

1 Department of Research and Innovation, St. Luke's University Health Network, Bethlehem, Pennsylvania, USA

2 Department of Anesthesiology, The Ohio State University College of Medicine, Columbus, Ohio, USA


3 Emergency Medicine Residency Program, Sarasota Memorial Hospital, Florida State University, Florida, USA

4 Global Communicable Diseases, College of Public Health, University of South Florida, Tampa, Florida, USA

5 Department of Cardiothoracic Surgery, The Medical Center of Aurora, Aurora, Colorado, USA

*Address all correspondence to: stawicki.ace@gmail.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Stawicki, S.P., M.S. Firstenberg, and T.J. Papadimos, *The Growing Role of Social Media in International Health Security: The Good, the Bad, and the Ugly*, in *Global Health Security*. 2020, Springer. p. 341-357.
- [2] Sahni H, Sharma H. *Role of social media during the COVID-19 pandemic: Beneficial, destructive, or reconstructive?* International Journal of Academic Medicine. 2020;**6**(2):70
- [3] Liu F-K. *Human security in the Asia Pacific: perspective of food and health security*. Asia Pacific Journal of Clinical Nutrition. 2009;**18**(4):669
- [4] Quinn SC, Kumar S. *Health inequalities and infectious disease epidemics: a challenge for global health security*. Biosecurity and bioterrorism: biodefense strategy, practice, and science. 2014;**12**(5):263-273
- [5] Heymann DL et al. *Global health security: the wider lessons from the west African Ebola virus disease epidemic*. The Lancet. 2015;**385**(9980):1884-1901
- [6] Stanely, N., et al. *Global Health Security and Disaster Forensics: A solution oriented approach to mapping public health vulnerabilities through predictive analytics*. in *E-Proceedings of the 38th IAHR World Congress*. 2019.
- [7] Giorgadze T et al. *Disasters and their consequences for public health*. Georgian Medical News. 2011;**194**:59-63
- [8] Whitmee S et al. *Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health*. The Lancet. 2015;**386**(10007):1973-2028
- [9] Horton R et al. *From public to planetary health: a manifesto*. The Lancet. 2014;**383**(9920):847
- [10] Bernstein S, Cashore B. *Can non-state global governance be legitimate? An analytical framework*. Regulation & Governance. 2007;**1**(4):347-371
- [11] Nayyar, D., *Towards global governance*. Governing Globalization: issues and institutions. Oxford: Oxford UP, 2002: p. 3-18.
- [12] Schrijver, N.J. and F. Weiss, *International law and sustainable development: principles and practice*. Vol. 51. 2004: Martinus Nijhoff Publishers.
- [13] Andrus JK et al. *Global health security and the International Health Regulations*. BMC Public Health. 2010;**10**(1):1-4
- [14] McRae, R. and D. Hubert, *Human security and the new diplomacy: Protecting people, promoting peace*. 2001: McGill-Queen's Press-MQUP.
- [15] Kalra S et al. *The emergence of ebola as a global health security threat: from 'lessons learned' to coordinated multilateral containment efforts*. Journal of Global Infectious Diseases. 2014;**6**(4):164
- [16] Sikka V et al. *The emergence of Zika virus as a global health security threat: a review and a consensus statement of the INDUSEM Joint Working Group (JWG)*. Journal of Global Infectious Diseases. 2016;**8**(1):3
- [17] Masys, A.J., R. Izurieta, and M.R. Ortiz, *Global Health Security*. 2020: Springer.
- [18] Stawicki SP et al. *The 2019-2020 novel coronavirus (severe acute respiratory syndrome coronavirus 2) pandemic: A joint american college of academic international medicine-world academic council of emergency medicine multidisciplinary COVID-19 working group consensus paper*. Journal of Global Infectious Diseases. 2020;**12**(2):47

- [19] Casale, M., *COVID-19: Can this crisis be transformative for global health?* Global Public Health, 2020: p. 1-13.
- [20] McBain, A., *Pandemic: The inextricable link between human, animal and ecosystem health and the emergence of communicable disease.* 2020.
- [21] Le NK et al. *International Health Security: A Summative Assessment by ACAIM Consensus Group*, in *Contemporary Developments and Perspectives in International Health Security-Volume 1.* 2020. IntechOpen.
- [22] Kulczyński M et al. *Air transport and the spread of infectious diseases.* World Scientific News. 2017;**76**:123-135
- [23] O'Connor, C. and M. Murphy, *Going viral: doctors must tackle fake news in the covid-19 pandemic.* *bmj*, 2020. **24**(369): p. m1587.
- [24] Stawicki, S.P., et al., *Introductory Chapter: Patient Safety is the Cornerstone of Modern Health-Care Delivery Systems*, in *Vignettes in Patient Safety-Volume 4.* 2019, IntechOpen.
- [25] Stawicki SP, Firstenberg MS. *Introductory chapter: The decades long quest continues toward better, safer healthcare systems.* *Vignettes in Patient Safety.* 2017;**1**:1
- [26] Saeed, M., et al., *Fact versus conjecture: Exploring levels of evidence in the context of patient safety and care quality*, in *Vignettes in Patient Safety-Volume 3.* 2018, IntechOpen.
- [27] Pal R et al. *The 2014 Academic College of Emergency Experts in India's INDO-US Joint Working Group (JWG) white paper on "developing trauma sciences and injury care in India"*. *International Journal of Critical Illness and Injury Science.* 2014;**4**(2):114
- [28] Joshi, A., et al., *Academic College of Emergency Experts in India's INDO-US joint working group (JWG) white paper on the integrated emergency communication response Service in India: much more than just a number!* *Journal of Emergencies, Trauma, and Shock.* 2013. **6**(3): p. 216.
- [29] Korta, S.M., *Fake news, conspiracy theories, and lies: an information laundering model for homeland security.* 2018, Naval Postgraduate School Monterey United States.
- [30] Analytica, O., *Distortion by social media bots will become targeted.* Emerald Expert Briefings, (oxan-db).
- [31] Walters RM. *How to Tell a Fake: Fighting Back against Fake News on the Front Lines of Social Media.* *Tex. Rev. L. & Pol.* 2018;**23**:111
- [32] Plaza M et al. *The use of distributed consensus algorithms to curtail the spread of medical misinformation.* *International Journal of Academic Medicine.* 2019;**5**(2):93
- [33] Mercy_Corps. The world's 5 biggest refugee crises. 2020 July 30, 2020; Available from: <https://www.mercycorps.org/blog/worlds-5-biggest-refugee-crises>.
- [34] WHO. *Health of Migrants - The Way Forward.* 2020 July 30, 2020; Available from: https://www.who.int/migrants/publications/mh-way-forward_consultation-report.pdf?ua=1.
- [35] Kivela P. *Paradigm Shift for COVID-19 Response: Identifying High-risk Individuals and Treating Inflammation.* *Western Journal of Emergency Medicine.* 2020;**21**(3):473
- [36] Chauhan V et al. *State of the globe: The trials and tribulations of the COVID-19 pandemic: Separated but together, telemedicine revolution, frontline struggle against "Silent Hypoxia," the relentless search for novel therapeutics and vaccines, and the daunting prospect of "COVIFLU"*. *Journal of Global Infectious Diseases.* 2020;**12**(2):39

- [37] Castells-Quintana, D., M.d.P. Lopez-Uribe, and T. McDermott, *Coping with climate risk: the role of institutions, governance and finance in private adaptation decisions of the poor*. 2015.
- [38] Paul E, Brown GW, Ridde V. *COVID-19: time for paradigm shift in the nexus between local, national and global health*. *BMJ Global Health*. 2020;5(4):e002622
- [39] Baker, S.R., et al., *The unprecedented stock market reaction to COVID-19*. The Review of Asset Pricing Studies, 2020.
- [40] Zaman, K.T., et al., *COVID-19 Pandemic Burden on Global Economy: A Paradigm Shift*. 2020.
- [41] Stawicki SP et al. *Academic college of emergency experts in India's INDO-US Joint Working Group and OPUS12 foundation consensus statement on creating a coordinated, multi-disciplinary, patient-centered, global point-of-care biomarker discovery network*. *International Journal of Critical Illness and Injury Science*. 2014;4(3):200
- [42] Le NK et al. *What's new in Academic International Medicine? International health security agenda—Expanded and re-defined*. *International Journal of Academic Medicine*. 2020;6(3):163
- [43] Tsavoussis A et al. *Child-witnessed domestic violence and its adverse effects on brain development: a call for societal self-examination and awareness*. *Frontiers in Public Health*. 2014;2:178
- [44] Tsavoussis A, Stawicki SP, Papadimos TJ. *Child-witnessed domestic violence: An epidemic in the shadows*. *International Journal of Critical Illness and Injury Science*. 2015;5(1):64
- [45] Hon HH et al. *What's new in critical illness and injury science? Nonaccidental burn injuries, child abuse awareness and prevention, and the critical need for dedicated pediatric emergency specialists: Answering the global call for social justice for our youngest citizens*. *International Journal of Critical Illness and Injury Science*. 2015;5(4):223
- [46] Frist WH. *Overcoming disparities in US health care*. *Health Affairs*. 2005;24(2):445-451
- [47] Patychuk, D., *Health equity and racialized groups: a literature review*. Health Equity Council and Health Nexus. Retrieved from http://www.healthnexus.ca/projects/building_capacity/index.htm, 2011.
- [48] Keays, M., *The Critical Discussion of Race and Racism Toward Achieving Equity in Health Policy*. Health Equity and Nursing: Achieving Equity Through Policy, Population Health, and Interprofessional Collaboration, 2020: p. 243.
- [49] Schrecker T. *The Political Economy of Public Health: Challenges for Ethics*. *The Oxford Handbook of Public Health Ethics*; 2019
- [50] Wikipedia. *2020 Beirut Explosions*. 2020 August 13, 2020; Available from: https://en.wikipedia.org/wiki/2020_Beirut_explosions.
- [51] Wikipedia. *2015 Tianjin explosions*. 2020 August 13, 2020; Available from: https://en.wikipedia.org/wiki/2015_Tianjin_explosions.
- [52] Marchigiani R et al. *Wind disasters: A comprehensive review of current management strategies*. *International Journal of Critical Illness and Injury Science*. 2013;3(2):130
- [53] Lenain, P., M. Bonturi, and V. Koen, *The economic consequences of terrorism*. 2002.
- [54] Lueddeke, G., *Global population health and well-being in the 21st century: toward new paradigms, policy, and practice*. 2015: Springer Publishing Company.

[55] Ventola CL. *The drug shortage crisis in the United States: causes, impact, and management strategies*. Pharmacy and Therapeutics. 2011;**36**(11):740

[56] Bhandari P. et al. Cancer-causing Chemical Detected in Commonly Prescribed Blood Pressure Medication.

[57] FDA. *Warning Letter: Torrent Pharmaceuticals Limited*. 2019 August 13, 2020; Available from: <https://www.fda.gov/inspections-compliance-enforcement-and-criminal-investigations/warning-letters/torrent-pharmaceuticals-limited-585255-10082019>.

[58] Lorenz EN. *Deterministic nonperiodic flow*. Journal of the Atmospheric Sciences. 1963;**20**(2):130-141

[59] Wikipedia. *Human overpopulation*. 2020 August 13, 2020; Available from: https://en.wikipedia.org/wiki/Human_overpopulation.

International Health Security: A Summative Assessment by ACAIM Consensus Group

Nicole K. Le, Manish Garg, Ricardo Izurieta, Sona M. Garg, Thomas J. Papadimos, Bonnie Arquilla, Andrew C. Miller, Abbas M. Khan, Tamara Worlton, Michael S. Firstenberg, Sagar Galwankar, Sunil Raina, Harry L. Anderson III, Rebecca Jeanmonod, Donald Jeanmonod, Ijeoma Nnodim Opara, Kristiana Kaufmann, Juan A. Asensio and Stanislaw P. Stawicki

Abstract

International health security (IHS) encompasses any natural or anthropogenic occurrence that can threaten the safety of human health and well-being. The American College of Academic International Medicine IHS Consensus Group (ACAIM-CG) developed a summative assessment highlighting the main issues that can impact IHS including emerging infectious diseases; chronic health conditions; bioterrorism; planetary changes (volcanic eruptions, earthquakes, wildfires, and climate change); nuclear incidents; information and cyber health; industrialization; globalization; pharmaceutical production; and communication platforms (social media). These concerns can directly and indirectly impact IHS both in the long and short term. When considering IHS, we aim to emphasize the utility of applying a predefined framework to effectively approach health security threats. This framework comprises of prevention, detection, assessment, reporting, response, addressing needs, and the perpetual repetition of the above cycle (inclusive of appropriate mitigation measures). It is hoped that this collective work will provide a foundation for further research within the redefined, expanded scope of IHS.

Keywords: global health security, international health security, consensus statement, redefined scope, expanded definition, summative assessment

1. Introduction

International health security (IHS), also referred to as “global health security” or “public health security,” consists of topics that are directly or indirectly tied to the well-being of humankind and broadly understood “safety from harm” [1]. First outlined

by the United Nations in 1994, the definition of “health security” continues to be nebulous, with somewhat of an incomplete overlap between the primary domains of “health” and “security” [2]. Thus, some controversy exists regarding both the degree of overlap and its precise context. In general, more recent IHS applications pertain to emerging infectious diseases (EIDs) and the threat of bioterrorism (BT) [3, 4]; however, the primary domain can be defined much more broadly when one considers the potential impact of various human-made and non-human-made events or factors on “health security” from the global health (GH) governance perspective [5–8]. Within the latter subset, a number of important topics emerge, including climate change, nuclear incidents, and misuse of global media platforms (both traditional and nontraditional) to disseminate medical (and public health-related) misinformation [9–11]. This summative assessment provides a high-level overview of issues that have the potential to directly or indirectly impact IHS. It was compiled specifically to reflect and highlight the perspective of Academic International Medicine (AIM) as previously defined by the American College of Academic International Medicine (ACAIM) [12].

2. International health security: the mechanism for sustainable development

To streamline the Consensus Group’s (CG) effort, the discussion will focus on the most relevant topics within the overall scope of IHS, with the following general operational outline:

1. **Overarching structure of discussion:** Prevent → Detect → Assess & Mitigate → Report → Respond → Address needs → Cycle repetition (see **Figure 1**)
2. **Key areas of discussion:** Emerging infectious diseases (including anti-microbial resistance); chronic conditions and access to medical treatment (e.g., diabetes, heart disease, and respiratory and renal insufficiency); social determinants of health; bioterrorism (biological weapons); chemical exposures (industrial and nonindustrial); Earth changes and their relationship to IHS (e.g., natural disasters: volcanic events and natural fires, coastal changes [not mentioned as a subsection in body of text]) and emergence of invasive species (not mentioned as a subsection in body of text); nuclear accidents; cyber health security (including personal data theft, social media misuse, and news disinformation); and various risks associated with human activity (e.g., industrial pollution, pharmaceutical manufacturing and distribution, global travel, and armed conflict).

At this juncture, a brief outline of the summative assessment (SA) discussion structure will be provided, focusing on the IHS improvement cycle that starts and ends with prevention (**Figure 1**):

1. **Prevention:** The foundation of a sustainable IHS framework is a focus on prevention; previously identified IHS threats should be subject to appropriate preventive strategies, including continuous effort within communities to ensure that an optimal environment exists for the avoidance of factors (or circumstances) conducive to the emergence or re-emergence of IHS threats
2. **Detection:** An organized, system-based methodology for collecting key information that facilitates the discovery of a broad range of potential IHS threats;

strict definitions and expectation of timeliness should be built into the reporting system to avoid potentially harmful delays

3. **Assessment:** An organized, system-based approach toward evaluating potential IHS threats and categorizing such potential threats into a reportable database. An important part of the assessment process is the estimation of item-specific risk(s) and urgency
4. **Reporting:** A structured communication procedure consisting of categorized items that are grouped according to IHS threat type and are assigned corresponding levels of priority/urgency
5. **Response:** An organized and highly coordinated series of steps designed to proactively address any potential IHS threats while setting up the stage to address any associated population health needs; mitigation efforts are put into place in case of prevention failures
6. **Addressing needs:** A structured process that features its own assessment cycle, designed to catalog, prioritize, and provide resources (financial and nonfinancial) required to effectively deal with the IHS threat aftermath; embedded within this phase is also the early stage of short-term and long-term preventive efforts
7. **Cycle repeats:** Once completed, the process returns to the preventive focus, with detection of new IHS threats triggering new/additional operational cycles.



Figure 1. *The international health security improvement cycle: safety & surveillance through prevention, detection and assessment; action through reporting, response, and addressing needs.*

At this point, our attention will turn to a list of specific IHS threats, beginning with emerging infectious diseases and ending with the emerging risk of weaponizing social media to disseminate potentially harmful medical/health-related information.

3. Emerging infectious diseases

The emergence (and re-emergence) of pathogens represents a significant threat to public health, including both high-income regions (HIRs) and low/middle-income regions (LMIRs) [13–17]. Detection of new IHS threats in this domain is challenging, primarily due to the nonspecific and often insidious nature of the emergence of a particular infection or pathogen [18–20]. Potential EIDs can arise from epidemic-prone, vaccine-preventable, vector-borne, food-borne, zoonotic, and/or antibiotic-resistant pathogens, or from a lack of access to safe water and sanitation [21–23]. In addition to lost lives, these diseases can lead to significant economic strain and may overburden local health system(s) capacity [24]. The lessons learned from prior outbreaks can help to improve future responses to emerging infectious diseases [24, 25].

For example, the well-documented response to the 2014 Ebola outbreak not only revealed a vulnerability to this important IHS threat, but also exposed significant inefficiencies of the current global public health infrastructure [26]. The initial response was disorganized and uncoordinated. The tracking of cases was also inadequate as the case trajectory deceptively appeared to decline before the true transmission spanned internationally [27]. Moreover, transmission was able to increase at an accelerating rate due to an overburdening of local health-care systems, lack of communication timeliness within the existing surveillance system, rapid urbanization, and widespread poverty where people lacked access to adequate water and waste management infrastructure [28–32]. Finally, even when there are ample resources available to address EID threats, local conflicts may effectively render any public health initiatives and medical efforts either highly dangerous or potentially impossible [33, 34].

To prevent the emergence or re-emergence of potentially life-threatening diseases, necessary measures must be initiated. Such measures include, but are not limited to, active surveillance for (timely response to) outbreaks. Emphasis must be placed on education and dissemination of key information to all stakeholders, antibiotic stewardship, vector control, and increased efforts toward combatting poverty and improving water and waste management [15, 35–37]. One important factor to consider when combatting EIDs is the need to coordinate all efforts as a unified, global front [16]. In a world characterized by continual globalization, phenomena such as mass migration and increasing ease of travel take on extreme importance to IHS [38, 39]. Collectively, the above factors may lead to accelerated spread of certain diseases and when coupled with inadequate response, lack of recognition, and limited awareness of various associated risks, local outbreaks can easily escalate into pandemics [20, 40, 41]. Finally, as the global community begins to expand the collective focus to include some of the more prevalent chronic, communicable and noncommunicable diseases, necessary assurances will be required that any corresponding public health initiatives will receive ample funding across all domains and services. Moreover, systemic mechanisms will need to be established to ensure continuous reassessment, training, and readiness to prevent the emergence of international complacency.

4. Chronic health conditions and access to care

With the aging of the world population, the increasing prevalence of chronic health conditions (CHCs), from diabetes to depression, is becoming an urgent

public health issue [42–44]. This is especially true in the context of access to care across LMIR. The aging world population (ages ≥ 60 years) is increasing and expected to triple in size from 962 million in 2017 to 3.1 billion in 2100 [45]. A significant proportion of this growing population segment will come from today's LMIR [46], and much of this growth has been attributed to improved medical care, resulting in longer life expectancy [47, 48]. In addition, the world population is aging in association with decreased fertility rates [49, 50]. Along with an aging population come CHCs that collectively must be viewed as an international security threat, especially as resource-to-patient ratios begin to decline. Dementia, heart disease, diabetes, obesity, mental health disorders, stroke, human immunodeficiency virus (HIV), sexually transmitted diseases (STDs), malnutrition, sensory impairments, substance abuse, polypharmacy, bladder irregularities, and mobility issues are a few of the most common CHCs facing this emerging elderly population, with LMIRs challenged the hardest [48, 51–53].

These barriers may become further compounded by external factors. Competing forces such as rising health-care costs and physician/provider shortages will require creative solutions. Strategies aiming for long-term sustainability can utilize technology, focus on innovation, and create global economies of scale [43, 54]. Specific examples include at-home primary care, telemedicine, preventative initiatives, and community/family engagement [43, 54–56]. As access to care in many LMIRs is difficult, home health and telemedicine programs will need to replace less efficient models where transportation to and from health-care facilities was the norm [57, 58]. Community educational programs can aid in informing patients and family members about in-home care for the aging.

Thanks to rapid advances in telecommunication, most of the world has access to “smart phone” technology, and telemedicine options based on this technology can provide portable care in places where traditional health-care information infrastructure is inadequate or outdated [59, 60]. Improved preventative measures such as diabetes/cardiovascular screening may be initiated with point-of-care (POC) technology, including behavioral modifications that result in improved health, wellness, and continuity of care [61, 62]. Community engagement, with dedicated non-health care degree personnel trained in specific interventions, will be valuable when expanding the existing health-care workforce. Similarly, providing employment or volunteering opportunities for the elderly can keep the aging population engaged, active, and reinvested in their own communities [63, 64].

In addition to the operational solutions described above, CHCs in the aging LMIR populations can benefit from patient-centered care. To ensure sustainability, decreasing overall disability in the geriatric population will become imperative. Providing proper dental care, hearing aids, glasses, devices to assist in mobility, and relevant group activities can promote personal independence, socialization, and mobility [53]. Nutrition support from local farming connected to food banks, meal delivery from food programs, or food sharing mechanisms involving group meals can ensure that patients are achieving a proper diet while remaining invested within the community [65, 66].

Important from a variety of perspectives and dimensions, early discussions of end-of-life (EOL) care can help reconcile patient and community goals while decreasing unnecessary, costly EOL interventions [67]. Home hospice, ethical EOL policy measures, and better community education can improve patient experiences [68]. CHCs in the aging population of LMIRs must be addressed in a proactive and systematic manner. Highlighting goals of care to maximize the quality of life, enhancing independence while decreasing disability, and creating safe, secure access to health-care in an innovative, technological manner will be imperative for health systems to effectively address the emerging elderly population in LMIRs [68, 69].

5. Social determinants of health

An important component of IHS is the development and continued focus on social determinants of health (SDH). This broad umbrella term encompasses the economic and societal conditions that affect an individual's health and underlines the interconnectedness of development and health. Although there is no pre-defined set of SDH parameters, commonly accepted components include: access to health-care, education, employment, socioeconomic status, and safe physical environment—for example, neighborhood and social support networks [70]. These factors are the outcome of public policy and not traditionally considered under the auspices of healthcare but are increasingly recognized as important factors in a society's well-being.

The WHO Commission on Social Determinants of Health (CSDH) recommended a multifaceted approach to address inequity in SDH, which included housing options; employment options; educational opportunities; universal healthcare; gender equality; fiscal responsibility and opportunity; and social programs as well as monitoring, assessment, and evaluation of interventions for effectiveness [71]. In 2011, 125 member states signed the Rio Political Declaration on Social Determinants of Health and this was subsequently adopted as World Health Assembly resolution 65.8 in 2012. The document focuses on equitable policy toward development and healthcare, SDH-focused policy-making, and global collaboration and accountability for SDH policy [72].

Social determinants of health do not constitute a fixed idea and should therefore be considered a dynamic and evolving concept (and process). The inclusion of gender identity among SDH highlights the importance of continued vigilance to identify and address health inequities [73]. The interlinked nature of these factors makes it clearly evident that SDH and health security can be impacted by nearly every aspect of policy and is not limited by national borders. Let us consider the case of climate change and its impact on numerous health determinants, including employment, air quality, food security, invasive species, agriculture, and housing options. Within this broader context, LMIRs will be disproportionately affected and without sufficient resources, the optimization of SDH for best health outcomes across potentially affected populations becomes increasingly difficult. The unpredictable nature of change may manifest in numerous ways, from supply chain interruptions to health-care infrastructure damage [74, 75]. Recognizing the need for continued advocacy, the WHO created a Department of Social Determinants of Health to lead the SDH effort for the WHO 13th General Programme of Work 2019–2023.

The final recommendation from the CSDH was for assessment, monitoring, and evaluation of interventions. There has been some work to determine feasibility and accuracy of monitoring for specific SDH indicators; however, future national and international programs should consider building intrinsic capability of SDH assessment [76].

6. Biological and chemical terrorism

In 2016, there were more than 13,000 terrorist attacks around the world resulting in over 34,000 deaths [77]. The IHS expert community has never faced this level of complexity and such diverse array of biological and chemical agents that can cause death, morbidity, disability, social disruption, and economic loss [78, 79]. Humans have engaged in biological and chemical warfare for centuries, with some of the historical applications including deliberate use of manure, plague victims,

and dead animals; the delivery of smallpox-infected blankets to Native American tribes; poisoning of wells with shigella and cholera; and the dispersing of plague-infested fleas by the Japanese in Manchuria during World War II [80–82]. Beyond biological warfare, the use of chemical agents to hurt other humans goes back over 10,000 years, from application of poison to spear tips, to the poisoning of Athenian wells by Sparta, the use of battlefield chemical weapons in World War I, and the Nazi development of the most lethal nerve agents [83–93].

The Centers for Disease Control and Prevention (CDC) have defined biological terrorism, or bioterrorism, as the use of biological agents (microbes, toxins, viruses) as weapons to further personal, religious, or political agendas [94, 95]. Acts of bioterrorism range from a single exposure directed at an individual by another individual, to wider scale biological warfare resulting in mass casualties. This definition may also be extended to include the infliction of harm that involves animals and plants/crops (a.k.a., econo-bioterrorism) [96–100]. Bioterrorism is often considered jointly with chemical terrorism, which is the release of nerve agents (organophosphorus compounds—e.g., sarin gas); vesicants, which damage skin and mucous membranes (i.e., mustard gas and Lewisite); agents affecting the airway and lungs (i.e., choking agents, phosgene gas); and/or cyanide agents affecting cellular respiration (e.g., hydrogen cyanide and cyanic chloride) [101–103].

Today's risk of biological or chemical terrorism is high because of a normative erosion of the social anathema regarding the use of biological and chemical weapons [104]. Specifically, such erosion has occurred because of the modern-day contempt for the 1925 Geneva Protocol, the 1972 Biological Weapons Convention, and the 1993 Chemical Weapons Convention, which collectively outlaw “the development, production, stockpiling, acquisition, and use of chemical and biological weapons [104].” Additionally, the rise of affordable small-scale science and technology capacity linked with the emergence of asymmetrical warfare (i.e., the interplay between smaller international actors versus traditional monolithic nation-states) is a serious threat to populations and resources [105, 106].

Specific recommendations by the CDC include five focus areas, with each area encompassing pertinent training and research: (a) preparedness and prevention; (b) detection and surveillance; (c) diagnosis and characterization of biological and chemical agents; (d) response; and (e) communication [107]. In addition, the authors of this report advocate strongly for the incorporation of mitigation efforts as critical to optimizing the effectiveness of the above-outlined incident response paradigm. To successfully address IHS threats, national and international institutions must provide measures aimed at augmenting public health diagnostics, including microbial recognition and typing, surveillance, enhanced pharmacological therapeutics (e.g., antimicrobials that can overcome resistance), vaccines, chemical sniffers, training, and education [96]. Where applicable, fast-tracking of innovations through various governmental and nongovernmental organizations (NGOs) will accelerate the work and delivery of new therapies and biological agent-specific vaccines to the field. Furthermore, implementation of clinical and field trials during a public health emergency (PHE) while at the same time respecting cultural differences between societies should be considered. Ensuring the provision of an ethical and just framework for such actions can accelerate the work and delivery of new therapies and vaccines to remedy the potential devastation of biological and chemical terrorism [40, 108].

7. Health security in the context of natural disasters

The planet Earth is our home within the indifferent emptiness of the known universe. Always changing and evolving, the Earth is not a static environment. And

while planetary changes (PCs) actively influence human activity and well-being, human civilization increasingly impacts the finely balanced planetary ecological and biophysical system [109]. The World Health Organization (WHO) 2006 Report on the estimate of the environmental contribution to disease mentions that about one-quarter of the global disease burden and more than one-third of the burden of disease among children may be attributable to PCs. Earth's environmental disequilibrium has been evidenced in the contamination of drinking water supplies, pollution of its atmosphere, and increasing number of natural fires that significantly affect human health [110]. Moreover, the 1990–2016 Burden of Disease study mentions environmental factors such as climate change, food scarcity, unsafe sanitation, occupational exposure to chemical substances, population displacements, and conflicts as having significant impact on human health [111, 112].

Based on the above developments, a new definition of “health” has emerged as an extension of the health concept established in the 1946 Constitution of the World Health Organization: “Health is a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity” [113]. This updated definition includes not only the complete well-being of human civilization, but also the well-being of the environmental systems on which humans depend for sustainability [114]. Consequently, economic policies should balance economic development, social progress, human health, and environmental sustainability. Health professionals have an essential role in advocating for the preservation of Earth's socioeconomic and natural environments in order to protect the health of current and future generations [112, 115]. The following sections will describe some of the more important topics within this general theme.

Volcanic events: Volcanic eruptions and associated earthquakes pose significant health security risk(s). Destructive aspects of eruptions include explosions, hot ash release, melted ice, lava, and gas emissions [116]. These events inherently affect human activity and health as more than 500 million people live in close proximity to volcanoes [117]. Volcanic explosions can cause burns, death, and traumatic injuries, often in an unpredictable fashion [118]. Between 1900 and 2009, approximately 100,000 deaths and nearly 5 million people were affected by volcanic events, with primary causes of mortality being ash asphyxiation, thermal injuries from pyroclastic flow, and trauma [117, 119]. Lava flows can cause burns, death, destruction of critical health infrastructure, and loss of property/land. Volcanic ash exposure can lead to pulmonary complications (including acute respiratory distress, suffocation, and chronic lung disease), ocular injuries/infections, and cutaneous reactions [120–125]. At higher elevations, ice melting can lead to flooding and mud slides. Moreover, volcanoes can emit harmful gases, which include carbon monoxide, sulfur dioxide, hydrogen fluoride, and $\text{CO}_2\text{H}_2\text{S}$ (carbon dioxide and hydrogen sulfide). These gases accumulate in low areas and are easily inhaled [116]. Several are colorless and odorless and can lead to respiratory distress, asphyxiation, and death. Volcanic ash containing crystalline silica can lead to pneumonoultramicroscopicsilicovolcanokoniosis and chronic lung disease. Volcano-associated earthquakes may cause structural damage and displacement [116]. Finally, there may be significant mental health sequelae (e.g., post-traumatic stress disorder or PTSD, and anxiety) [120–125].

Volcanic events have led to significant socioeconomic disruptions, affecting basic survival by negatively altering crops, livestock, water, heavy metal concentrations in the soil, and preventing access to healthcare [116, 126]. For example, the largest air transportation freeze since World War II occurred during the 2010 Icelandic Eyjafjallajökull eruption, where an estimated 107,000 flights were canceled during an 8-day period [127–129]. This single event affected nearly half of global air traffic, including 10.5 million stranded passengers and a staggering cost of \$1.7 billion [128, 129].

Volcanic event readiness requires a comprehensive approach, which involves preparation, an emergency action plan, and a post-disaster plan. In an event of an eruption, communities should have an emergency kit ready in their homes [130]. Flashlights with extra batteries, first aid supplies, emergency food and water along with a manual can opener, essential medicines, shoes, breathing protection, and eye protection are all recommended by the CDC [131]. During an eruption, affected communities should adhere to evacuation instructions by local authorities. Understanding local culture and customs aids in evacuation strategies, keeps emergency team members prepared, and allows for clear communication. Oftentimes, survivors of volcanic eruptions prefer to stay in their communities despite any future risk [132]. Consequently, avoiding harmful exposure is the most important strategy. Protective masks can prevent inhalation of ash particles and minimize respiratory symptoms if exposure is unavoidable. Although N-95 type masks are most effective, they can be poorly tolerated [133, 134]. Protecting eyes, removing contact lenses, and wearing clothing to cover open skin are among recommended measures [116]. Of importance, appropriate mitigation procedures should also be considered in case primary prevention measures fail. Post-disaster assistance and restoration will require internal and external cooperative efforts, and community involvement is critical. Teaching local community members how to treat burns, administer inhalers, provide oxygen, and give oral fluids for dehydration can greatly assist local health centers. Health-care providers in LMIRs will need to be adept at treating severe burns, preventing infection, and providing respiratory assistance to those in distress.

Earthquakes: Whether associated with volcanic events or isolated tectonic activity, earthquakes have a significant potential to impact local health-care capacity and health security, including the potential damage to hospitals, clinics, as well as possible disruptions to various political and social structures. When limited to smaller geographic areas or regions, the need for post-earthquake emergency surge capacity can be provided by nearby facilities that were not affected by the event. However, in cases of more widespread earthquake damage, or severe structural destruction that occurs within a geographically isolated area (e.g., as seen during the massive 2010 Haiti event), the damage to health-care infrastructure may reach sufficient magnitude to result in simultaneous threats to both public health (e.g., the ability to provide essential emergency medical services) and IHS (e.g., through secondary effects such as the possibility of population displacement, migration, and/or exacerbation of a preexisting conflict). Coordinated international relief action is indicated under such conditions.

7.1 Increased risk and impact of natural fires

The fires in the Amazon rainforest of Brazil have been a source of great concern among the environmentalists and climate scientists [135]. However, the response of health-care professionals has been surprisingly muted despite the consensus that extensive Amazon fires may have far-reaching effects on human health and IHS. In fact, the current response is a far cry from our response to other health-care emergencies or epidemics. The reasons include reluctance to engage in a multi-stakeholder model of mitigating health-care concerns, the general acceptance of national health systems “existing in silos,” and more generally the failure to appreciate the health-care implications of climate change taking place around us.

The major portion (~60%) of the Amazon, covering more than 2 million square miles in Brazil, is often called “the planet’s lungs” and the carbon “sink” [136, 137]. In fact, it has been estimated that the Amazon is responsible for processing vast quantities of carbon dioxide and providing about 20% of the world’s oxygen [138, 139]. Of importance, it is estimated that about 20% of the rainforest has already been lost,

with the tipping point or “danger zone” for human well-being being not too far, at approximately 25% total rainforest capacity lost [140, 141]. While a nontrivial proportion of the Amazon fires may have been set intentionally (e.g., to clear the land for various forms of local economic endeavors), we must remember that this activity only deepens the current climate crisis by destroying CO₂-absorbing capacity while actively releasing vast quantities of CO₂ into the atmosphere [141]. The current wave of Amazon fires represents the highest number of such events in nearly a decade, with a clear relationship to deforestation activity [142, 143].

Human effects attributable to tropical forest fires may be more pronounced than we think. In a more direct fashion, the respiratory system is exposed to various levels of smoke, with an associated presence of various volatile chemical agents [144]. This may contribute to both short-term and long-term pulmonary sequelae, including acute respiratory infections, chronic obstructive pulmonary disease exacerbations, and bronchial asthma [144, 145]. Emergency visits due to ocular exposures with resultant eye irritations have also been reported [145]. In another report, smoke exposures were associated with increased incidence of self-reported symptoms, medication use, outpatient and emergency room visits, hospital admissions, and mortality [146]. The strongest associations were noted between forest fire smoke exposure and asthma [146].

More indirectly, forest fires and the associated gradual climate change may also be affecting non-pulmonary organ systems. A recently published commentary proposes a potential link between chronic kidney disease of unknown origin (CKDu)—also known in Central America as Mesoamerican nephropathy—and greenhouse gas emissions [147]. The report is based on experiences with CKDu in El Salvador in the 1990s, when unusually large numbers of agricultural workers began dying from irreversible renal failure. The report finds the phenomenon to be pervasive among agricultural communities in hot, humid regions of Central America, suggesting an important contributory role of local climate characteristics [148, 149]. This may be further corroborated by reports of CKDu among sugarcane workers in Central America, who work, heavily clothed, in temperatures that frequently surpass 40°C (104°F) [148]. It has been proposed that CKDu may represent a form of heat-stress nephropathy that is associated with rapidly evolving environmental conditions [148, 150].

This important area of clinical investigation requires significantly more investment and resources so that we can better prepare for the consequences of environmental changes due to forest fires and global warming in general. Significant increases in severity and frequency of fires have been noted across the globe [151–155]. As health-care providers, we must venture beyond our traditional focus of medicine and therapeutics, and begin taking a more active role in advocacy, prevention, and mitigation. This will require multidisciplinary approaches that integrate elements of environmental science into clinical practice and public health [156, 157]. High-quality early warning systems should be developed to help protect vulnerable populations using “an epidemic prevention model strategy” employed in other areas of public health [158, 159]. Ample support must be provided for research into “climate-sensitive diseases” [160]. Appropriate rapid response capability should be integrated into public health systems around the globe.

8. Nuclear incidents and health security

Nuclear incidents can be broadly divided into military and civilian occurrences. Although military events (e.g., nuclear war, nuclear terrorism, and nuclear weapons testing) are of great importance in the overall contexts of potential modulation of planetary change, such scenarios are beyond the scope

of the current chapter. For completeness, we are directing the reader to other sources referenced herein [10, 161–165].

The focus of this section will be on civilian nuclear occurrences. Within this subdomain, radioactive exposures can be broadly classified as either medical (e.g., health-care equipment used for radiation therapy, reagents used in nuclear medicine) [10, 166] or industrial (e.g., power generation, by-products of medical or military production, long-term storage of nuclear waste) [10, 167]. We will briefly discuss each of these—in fairly general terms—focusing on potential implications to various aspects of IHS.

Health-care related exposures tend to be contained to the immediate environment surrounding the area of radioactive contamination. One historical event of significance took place in Goiania, Brazil [166]. Another incident occurred in Indiana, Pennsylvania [166]. In both cases, injuries and mortalities were limited to a small number of directly affected individuals. Of importance, the Goiania incident involved negligent removal and disposal of 50.9 TBq of Cesium 137 from a radiotherapy unit [168]. Environmental contamination requires high-intensity cleanup efforts, with generally acceptable results despite some degree of persistent residual radiation exposure risk [169]. Of note, post-event psychological and behavioral effects (termed “radiophobia” and similar to PTSD) were noted among survivors [170, 171].

In terms of industrial exposures, some of the most significant incidents involve the nuclear power plant explosion in Chernobyl, Ukraine (Former Soviet Union) [172] and the more recent nuclear reactor meltdowns at the Fukushima Daiichi Nuclear electric plant [173]. Both incidents exemplify the potential for long-term adverse effects of radioactive isotope releases on the immediate surroundings [174, 175], as well as the more remote, much subtler downstream exposures secondary to radioisotope concentration within the food chain [176–178]. In terms of the associated impact on IHS, various studies estimated long-term and long-distance effects of resultant radioactive releases [178–181]. Similar to medical radiation incidents, both social and mental health consequences have been noted among those exposed [182, 183]. Associations with medical conditions, including malignancies, appear to be less specific and weaker [184–186]. Appropriately administered food and contamination control programs are effective in minimizing the risk of internal radiation exposure [178, 187]. Of importance, governmental agencies such as the United States Nuclear Regulatory Commission are tasked with the oversight, nuclear safety framework, emergency planning, and appropriate protective actions as it relates to civilian nuclear incidents.

9. Information and cyber health security

Health-care institutions have been increasingly aware of cyber health security (CHS) threats to our population and have taken measures to protect patients, visitors, and staff from such threats [188, 189]. Yet, despite this, the academic health-care community has been relatively slow to recognize and mitigate various cybersecurity threats [190]. Within this broad area of IHS, three aspects have been identified as most important:

- *Software supply chain attacks*: Attempts to infiltrate the information-technology (IT) infrastructure via a third-party vendor (e.g., EHR add-ons) or partner (e.g., HVAC) systems [191–193]. Symantec’s 2018 Internet Security Threat Report found a 200% increase in supply chain attacks across all industry sectors [193].

- *Internet of things (IOT) attacks*: The second area is the IOT attacks. More and more nontraditional devices are connected to the internet, which means devices that do not have the highest levels of security may become integrated into hospital networks [194–196].
- *Ransomware attacks*: Ransomware, one of the most common types of malware, utilizes malicious software to infiltrate computer systems or connected devices in order to encrypt a user's files [197]. Most commonly, servers for web and email applications, databases, end-user computers and removable media are involved [198]. Once encrypted, the information is indecipherable and inaccessible. The user receives a pop-up notification demanding payment of a ransom (usually in untraceable or difficult-to-trace digital currency) in exchange for the decryption key [199]. But ransomware does not destroy information; rather, it locks-up the data until a ransom is paid. Even if the ransomware infection is removed, the data remain encrypted [200]. Of note, the mere infection of a machine with ransomware is not sufficient, as the ransomware must communicate with a server to get an encryption key and report its results. This, in turn, requires a server hosted by a third-party company that will ignore the illegal activity and guarantee the attackers anonymity (called Bulletproof Hosting) [200]. Attackers also use a proxy or virtual private network (VPN) services to further disguise their own internet protocol (IP) addresses [200].

In February 2013, President Obama issued an Executive Order on Improving Critical Infrastructure Cybersecurity, with the goal of improving cybersecurity and reducing cyber threats to the nation's "critical infrastructure sectors," including the Healthcare and Public Health Sector [201]. The Executive Order defines "critical infrastructure" as "systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters" [201]. In other words, the executive order and other governmental policies collectively identify health-care systems and assets as so vital to the U.S. that their impairment would severely threaten public health and safety.

Many medical devices and other hospital assets now have direct access to the Internet—both in an encrypted (e.g., secured) and unencrypted (e.g., unsecured) fashion [202, 203]. Billing systems use electronic financial transfers, medical devices upload vital statistics in real time to EHRs, hospitals allow patients and visitors access to hospital WiFi as a courtesy, and patients are being provided access to protected health information (PHI) via authentication on the Internet—all of these are important and vital aspects of a modern hospital ecosystem [204–207]. As hospitals benefit from networked technology and greater connectivity, they also must ensure that they evaluate and manage these new risks. The American Hospital Association has identified the following priorities [208, 209]:

1. Establish procedures and a core cybersecurity (CS) team to identify and mitigate risks, including board involvement as appropriate.
2. Develop a CS investigation and incident response plan that is mindful of the CS Framework being drafted by the National Institute of Standards and Technology.

3. Investigate the medical devices used by the hospital in accordance with the June 2013 FDA guidance to ensure that the devices include intrusion detection and prevention assistance and are not currently infected with malware.
4. Review, test, evaluate, and modify, as appropriate, the hospital's incident response and data breach plans to ensure that the plans remain as current as possible in the changing cyber threat environment.
5. Consider engaging in regional or national information-sharing organizations to learn more about the CS risks faced by hospitals.
6. Review the hospital's insurance coverage to determine whether the current coverage is adequate and appropriate given CS risks.

10. Global communication platforms and social media: balancing benefits and threats

The role of social media platforms in IHS is substantial, and is likely to continue to grow [210]. There are certainly many positive aspects of social media (SM), such as the ability to quickly conduct population-level education, surveillance, and even preventive interventions [210]. At the same, there is the “dark side” potential of subverting these powerful platforms to both passively and actively facilitate harm and to disseminate misinformation [9]. Among the most challenging aspects of SM platform use in public health and IHS is the need for real-time verification and interception of potentially harmful messaging while at the same time promoting (and certainly not impeding) helpful content [9, 211].

The role of SM as a potential agent for dissemination of harmful medical misinformation tends to be underappreciated and/or intentionally minimized. Yet this health security threat is not only global but also represents a more pervasive form of harm, where incorrect, erroneous, or outright dangerous information becomes “entrenched” within the population's collective mind. A hypothetical example of medical misinformation may appear as follows, “all those who wash hands with alcohol solution expose themselves to deadly mutations and cancers.” When disseminated widely, through a combination of “likes” and “upvotes,” this dishonest and extremely harmful information may reach the status of “accepted reality” where people blindly believe in the validity of the damaging claim without critically evaluating its merits. In addition to potential harm and elevated risk to individuals, misuse of SM platforms can lead to population-level manifestations such as public anger and civil unrest [212].

In one real-life example where cultural norms, religious beliefs, and SM reinforcement played an important role in adversely influencing health security, the reluctance to comply with modified burial practices may have contributed to ongoing spread of Ebola virus during the 2014–2015 outbreak [24, 213]. In another instance, support for SM-based conspiracy theories around the Ebola pandemic abounded, while changes in infection prevention practices appeared to be lagging the dissemination of correct health information [25]. Finally, the unethical opportunism of false promises and exploitation of the naïve was highlighted by the emergence of unsubstantiated and harmful claims of “disease-modifying behaviors” that may actually lead to significant morbidity and/or mortality [213, 214], whether intentionally or not. One such example is the public health harm created by the anti-vaccination movement, which was greatly aided by the misinformed adoption of SM platforms as “trusted sources” [9]. At the governmental level, various organizations and agencies actively

work on responses and countermeasures to disinformation present across various media platforms, including the National Security Communications Team in the United Kingdom, the National Cyber Directorate in Israel, the National Cybersecurity Agency in France, and the Australian Security Intelligence Organization, among others.

11. Health security in the context of human activity and sustainability

11.1 Human activity

Above and beyond previously discussed topics, modern human activity has had a tremendous impact on both individual and population health and well-being [215]. Key etiological and inherently interrelated concepts include industrialization, globalization, information transfers, and social interactions. Each of these areas will now be discussed in greater detail.

- *Industrialization*: Industrialization is a key contributor to the contemporary health epidemics of obesity and cardiovascular disease—a phenomenon deeply rooted in a gradual human transition from agricultural production to service economies. Industrialization has led to increased energy demands, dependence on fossil fuels, and the resultant global warming [216, 217]. Planetary-level effects include extreme weather events, rising sea levels, dangerous heat waves, decreased crop yields and nutritional density, worsening air quality, and unpredictable patterns of vector-borne diseases [20, 150, 218–221]. Extreme weather events lead to greater devastation and consequently exacerbate disproportionate hardships faced by LMIRs, leading to downstream sequelae including mass hunger, migrations, and armed conflict [75, 150, 220, 222].
- *Globalization*: Globalization and an increase in human mobility have not only augmented global warming-induced risk of vector-borne diseases, but have promoted their rapid transmission [223, 224]. Increasing human interactions and interconnectedness, while having a positive effect on intercultural reliability and collaboration, have at the same time facilitated the globalization of violence through terrorism and destabilization of vulnerable governments [225–227].
- *Information transfers and social interactions*: The ease of information sharing is unprecedented in human history. While generally accepted to be positive, a downside of false information becoming amplified and leading to harmful downstream consequences has been increasingly noted with the advent of internet and SM [228]. Empowering untrained and self-professed experts to discredit established peer-reviewed medical literature is proving to be more destructive than previously believed [9, 229]. The current pervasiveness of SM gives the appearance of positivity and health promotion as it enables interconnectivity and maintenance of relationships. Unfortunately bullying and psychological trauma are quickly becoming a reality facilitated by this still emerging technology [230, 231].

When considering the above entities, a worrisome negative synergism becomes apparent. Moreover, the velocity and intensity of negative developments make compensation and adaptation difficult, and, too frequently, existing

governing bodies are unable to effectively address any enduring impacts [232, 233]. Consequently, calls for a global coalition committed to preventing adverse health effects from human activity are imperative.

12. Planetary climate change: a health security threat

Our planet is changing and evolving constantly, with continued climate transitions throughout the Earth's history becoming the scientifically accepted norm [234–236]. For the purposes of this discussion, we will refer to this complex set of phenomena simply as “planetary climate change” or PCC. Key areas affected by PCC include agriculture [237], forestry [238, 239], species migrations [240], vector-borne infectious diseases [241], urban air pollution [241], wind activity [75, 242], as well as changes in water availability [243]. Of importance, all of the above elements are closely interrelated, and it will be extremely difficult to elucidate any binary cause-and-effect relationships, making any debates around the topic of PCC both circumstantial and highly controversial. Beyond various direct and indirect effects of climate change on human health [244], it has been suggested that among the manifestations of the observed human response to PCC are armed conflict and widespread migration [245, 246].

Perhaps one of the most impactful aspects of the current PCC trends is the emergence of increasing temperature variability [247], which can, in turn, create local weather conditions that regions of the planet may simply not be prepared to handle effectively [248, 249]. One of the proposed models suggests the emergence of “severe and widespread droughts in the next 30-90 years” [235, 250], with clear implications to other topics discussed in this review such as food security, emerging infectious diseases, and human migrations [251].

Another important aspect of the overall management of PCC is the need to better understand any effects of solar (and even beyond that, cosmic) energetic inputs, with special focus on the relationship on such activity on the observed patterns of climate behavior [252, 253]. This includes the potential interplay between the Earth's magnetic field, solar output, and cosmic rays as climate modulators, including key determinants of various phenomena such as cloud formation [254–256]. Although far too vast—and inadequately understood—the topic of “planetary health” is by default the overarching determinant of human well-being and sustainability. In the United States, multiple organizations and agencies are involved in activities and actions revolving around PCC, including the Department of Agriculture, the US Agency for International Development, the National Science Foundation, the National Aeronautics and Space Administration, the Environmental Protection Agency, the Department of Transportation, and the Department of State, among others.

13. Pharmaceutical manufacturing and distribution: a clear health security concern

In 1982, seven people died in the greater Chicago, Illinois metropolitan area after consuming acetaminophen that had been intentionally laced with potassium cyanide [257]. While the response by the drug manufacturers has since been widely recognized and praised as a textbook case in corporate crisis and public relations management, the greater concern was the recognition of how vulnerable pharmaceuticals are to potential tampering and bioterrorism [258, 259]. As a result, the United States Food and Drug Administration (US FDA) and Federal Government—working jointly with pharmaceutical manufacturers—established

harsh anti-tampering laws and guidelines to limit the risk of further contamination of the drug supply [260, 261].

However, it became clear that such “tampering” events—especially if intentional—can occur on a global scale [258, 259]. This is particularly true when one considers the extensive worldwide supply-chain manufacturing process that is involved in the production of consumer pharmaceuticals. Even slight changes in a drug’s production—be it the initial recipes, mixing with drug stabilizers, buffers, or binders, all the way to packaging and distribution—can have catastrophic, if not fatal, consequences. The complexity of pharmaceutical development and distribution illustrates that there are numerous opportunities for sabotage, bioterrorism, neglect, or various forms of human error [262, 263]. Even local events can spark worldwide concerns and public fear. Any breakdown, intentional or otherwise, can compromise the safety of medications that millions depend on for their daily health. Potential observed effects may include avoidance of long-term maintenance medications, clinically significant manifestations of fear, and tremendous economic damage related to combined supply chain disruptions, in addition to increased downstream health-care costs.

While there are safeguards built into the entire process to assure pharmaceutical purity—including oversight by government agencies, such as the US FDA and European Union (EU) European Medicines Agency (EMA)—the system is not without potential risk. Many LMIR areas are challenged by the lack of appropriate regulatory oversight, government penalties, and even public (i.e., public company shareholders) accountability. In addition, pharmaceuticals that are no longer protected by intellectual property laws may be manufactured and distributed worldwide with lower regulatory or quality oversight [264, 265]. In fact, many well-established pharmaceuticals can vary significantly in their drug bio-availabilities and potencies depending on how and where they are manufactured [266, 267].

14. Conclusions

International health security is a complex and highly heterogeneous area of expertise. The American College of Academic International Medicine IHS Consensus Group (ACAIM-CG) developed a summative assessment highlighting the main issues that can impact IHS including emerging infectious diseases; chronic health conditions; bioterrorism; planetary changes (volcanic eruptions, earthquakes, wildfires, and climate change); nuclear incidents; information and cyber health; industrialization; globalization; pharmaceutical production; and communication platforms (social media). These concerns can directly and indirectly impact IHS both in the long and short term. When considering each IHS component, we aim to emphasize the utility of applying a predefined framework to effectively approach health security threats. This framework comprises of prevention, detection, assessment, reporting, response, addressing needs, and the ongoing repetition of this cycle (inclusive of appropriate mitigation measures). It is hoped that this collective work will provide a foundation for further research within the redefined, expanded scope of IHS.

Acknowledgements

The authors of this manuscript would like to thank all members of the ACAIM International Health Security Consensus Group, including non-author contributors, for their input and guidance throughout the process of drafting this important publication.

Glossary

BT	bioterrorism
CG	consensus Group
CHC	chronic health condition
CHS	cyber health security
EID	emerging infectious diseases
EOL	end-of-life
GH	global health
HIR	high-income regions
IHS	international health security
LMIR	low- and middle-income regions
NGO	nongovernmental organization
PC	planetary changes
PCC	planetary climate change
PHE	public health emergency
PHI	protected health information
POC	point-of-care
PTSD	post-traumatic stress disorder
SA	summative assessment
SDH	social determinants of health
SM	social media


Author details

Nicole K. Le¹, Manish Garg², Ricardo Izurieta³, Sona M. Garg⁴,
Thomas J. Papadimos⁵, Bonnie Arquilla⁶, Andrew C. Miller⁷, Abbas M. Khan⁷,
Tamara Worlton⁸, Michael S. Firstenberg⁹, Sagar Galwankar¹⁰, Sunil Raina¹¹,
Harry L. Anderson III¹², Rebecca Jeanmonod¹³, Donald Jeanmonod¹³,
Ijeoma Nnodim Opara¹⁴, Kristiana Kaufmann¹⁵, Juan A. Asensio¹⁶
and Stanislaw P. Stawicki^{17*}

1 University of South Florida College of Medicine, Florida, USA

2 Department of Emergency Medicine, New York Presbyterian Hospital, Cornell
and Columbia University Schools of Medicine, New York, NY, USA


IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

- 3 College of Public Health, University of South Florida, Tampa, Florida, USA
- 4 The Joint ACAIM-WACEM Working Group on International Health Security, Bethlehem, Pennsylvania, USA
- 5 Department of Anesthesiology, The Ohio State University College of Medicine, Columbus, Ohio, USA
- 6 Department of Emergency Medicine, SUNY Downstate Health Sciences University, Brooklyn, New York, USA
- 7 Department of Emergency Medicine, Nazareth Hospital, Trinity Health Mid-Atlantic, Philadelphia, Pennsylvania, USA
- 8 Department of Surgery, Global Surgery Division, Uniformed Services University, Bethesda, Maryland, USA
- 9 Department of Cardiovascular Surgery, The Medical Center of Aurora, Aurora, Colorado, USA
- 10 Emergency Medicine Residency Program, Sarasota Memorial Hospital, Florida State University, Florida, USA
- 11 Multidisciplinary Research Unit, Community Medicine, Government Medical College, Tanda, India
- 12 Department of Surgery, St. Joseph Mercy Ann Arbor, Ann Arbor, Michigan, USA
- 13 Department of Emergency Medicine, St. Luke's University Health Network, Bethlehem, Pennsylvania, USA
- 14 Departments of Medicine and Pediatrics, Wayne State University School of Medicine, Detroit, Michigan, USA
- 15 Department of Emergency Medicine, Wayne State University School of Medicine, Detroit, Michigan, USA
- 16 Department of Surgery, Creighton University School of Medicine, Omaha, Nebraska, USA
- 17 Department of Research and Innovation, St. Luke's University Health Network, Bethlehem, Pennsylvania, USA

*Address all correspondence to: stawicki.ace@gmail.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Chiu Y-W et al. The nature of international health security. *Asia Pacific Journal of Clinical Nutrition*. 2009;18(4):679-683
- [2] U.N.D. Programme. *Human Development Report 1994*. New York: Oxford University Press; 1994
- [3] Scharoun K, Van Caulil K, Liberman A. Bioterrorism vs. health security—Crafting a plan of preparedness. *The Health Care Manager*. 2002;21(1):74-92
- [4] Heymann DL et al. Global health security: The wider lessons from the west African Ebola virus disease epidemic. *The Lancet*. 2015;385(9980):1884-1901
- [5] Reiter P et al. Global warming and malaria: A call for accuracy. *The Lancet Infectious Diseases*. 2004;4(6):323-324
- [6] Hobson C, Bacon P, Cameron R. *Human Security and Natural Disasters*. Philadelphia, PA: Routledge; 2014
- [7] Brown T. ‘Vulnerability is universal’: Considering the place of ‘security’ and ‘vulnerability’ within contemporary global health discourse. *Social Science & Medicine*. 2011;72(3):319-326
- [8] Kay A, Williams O. *Global Health Governance: Crisis, Institutions and Political Economy*. London, UK: Springer; 2009
- [9] Plaza M et al. The use of distributed consensus algorithms to curtail the spread of medical misinformation. *International Journal of Academic Medicine*. 2019;5(2):93
- [10] Rojavin Y et al. Civilian nuclear incidents: An overview of historical, medical, and scientific aspects. *Journal of Emergencies, Trauma, and Shock*. 2011;4(2):260
- [11] Costello A et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. *The Lancet*. 2009;373(9676):1693-1733
- [12] Anderson HL III et al. Mission statement of the American College of Academic International Medicine. *International Journal of Critical Illness and Injury Science*. 2017;7(1):3
- [13] Hashemian F, Yach D. Public health in a globalizing world: Challenges and opportunities. In: Ritzer G, editor. *The Blackwell Companion to Globalization*. Malden, MA: Blackwell Pub.; 2007. pp. 516-538
- [14] De Cock KM et al. The new global health. *Emerging Infectious Diseases*. 2013;19(8):1192-1197
- [15] Sikka V et al. The emergence of Zika virus as a global health security threat: A review and a consensus statement of the INDUSEM Joint Working Group (JWG). *Journal of Global Infectious Diseases*. 2016;8(1):3-15
- [16] Kalra S et al. The emergence of Ebola as a Global Health Security threat: From ‘lessons learned’ to coordinated multilateral containment efforts. *Journal of Global Infectious Diseases*. 2014;6(4):164-177
- [17] Wojda TR et al. The Ebola outbreak of 2014-2015: From coordinated multilateral action to effective disease containment, vaccine development, and beyond. *Journal of Global Infectious Diseases*. 2015;7(4):127-138
- [18] Morse SS. Factors in the emergence of infectious diseases. In: Price-Smith AT, editor. *Plagues and Politics: Infectious Disease and International Policy*. Houndmills, Basingstoke, Hampshire, New York: Palgrave; 2001. pp. 8-26

- [19] Woelffer GB et al. A computer-assisted molecular epidemiologic approach to confronting the reemergence of tuberculosis. *The American Journal of the Medical Sciences*. 1996;**311**(1):17-22
- [20] Sikka V et al. The emergence of Zika virus as a global health security threat: A review and a consensus statement of the INDUSEM joint working group (JWG). *Journal of Global Infectious Diseases*. 2016;**8**(1):3
- [21] Kasowski EJ, Garten RJ, Bridges CB. Influenza pandemic epidemiologic and virologic diversity: Reminding ourselves of the possibilities. *Clinical Infectious Diseases*. 2011;**52**(Suppl 1):S44-S49
- [22] WHO. WHO Global Strategy for Containment of Antimicrobial Resistance. Geneva: WHO; 2001
- [23] Tappero JW, Tauxe RV. Lessons learned during public health response to cholera epidemic in Haiti and the Dominican Republic. *Emerging Infectious Diseases*. 2011;**17**(11):2087-2093
- [24] Kalra S et al. The emergence of Ebola as a global health security threat: From 'lessons learned' to coordinated multilateral containment efforts. *Journal of Global Infectious Diseases*. 2014;**6**(4):164
- [25] Abramowitz S et al. The opposite of denial: Social learning at the onset of the Ebola emergency in Liberia. *Journal of Health Communication*. 2017;**22** (suppl 1):59-65
- [26] Wojda TR, Valenza PL, Cornejo K, McGinley T, Galwankar SC, Kelkar D, et al. The Ebola outbreak of 2014-2015: From coordinated multilateral action to effective disease containment, vaccine development, and beyond. *Journal of global infectious diseases*. 2015;**7**(4):127
- [27] Baden LR et al. Ebola—An ongoing crisis. *The New England Journal of Medicine*. 2014;**371**(15):1458-1459
- [28] Flynn L, Bery R, Kaitano AE. *Emerging Infectious Diseases and Impact Assessments*. Canada: International Association for Impact Assessment; 2013
- [29] CIA. *The World Factbook: Liberia*. 2019. Available from: <https://www.cia.gov/library/publications/the-world-factbook/geos/li.html>. [Accessed: 13 January 2019]
- [30] CIA. *The World Factbook: Guinea*. 2019. Available from: <https://www.cia.gov/library/publications/the-world-factbook/geos/gv.html>. [Accessed: 14 January 2019]
- [31] CIA. *The World Factbook: Sierra Leone*. 2019. Available from: <https://www.cia.gov/library/publications/the-world-factbook/geos/sl.html>. [Accessed: 14 January 2019]
- [32] UNESCO. *UNESCO's Response to Ebola*. 2014. Available from: <https://unesdoc.unesco.org/ark:/48223/pf0000231158>. [Accessed: 15 January 2019]
- [33] Nakkazi E. *DR Congo Ebola Virus Outbreak: Responding in a Conflict Zone*. 2018
- [34] McPake B et al. Ebola in the context of conflict affected states and health systems: Case studies of northern Uganda and Sierra Leone. *Conflict and Health*. 2015;**9**(1):23
- [35] Thacker SB, Berkelman RL. Public health surveillance in the United States. *Epidemiologic Reviews*. 1988;**10**:164-190
- [36] Weaver SC. Urbanization and geographic expansion of zoonotic arboviral diseases: Mechanisms and potential strategies for prevention. *Trends in Microbiology*. 2013;**21**(8):360-363

- [37] Wagstaff A. Poverty and health sector inequalities. *Bulletin of the World Health Organization*. 2002;**80**(2):97-105
- [38] Gushulak BD, MacPherson DW. Globalization of infectious diseases: The impact of migration. *Clinical Infectious Diseases*. 2004;**38**(12):1742-1748
- [39] Gubler DJ. Dengue, urbanization and globalization: the unholy trinity of the 21st century. *Tropical Medicine and Health*. 2011;**39**(4 Suppl):S3-S11
- [40] Papadimos TJ et al. Ethics of outbreaks position statement. Part 1: Therapies, treatment limitations, and duty to treat. *Critical Care Medicine*. 2018;**46**(11):1842-1855
- [41] Snacken R et al. The next influenza pandemic: Lessons from Hong Kong, 1997. *Emerging Infectious Diseases*. 1999;**5**(2):195
- [42] Moussavi S et al. Depression, chronic diseases, and decrements in health: Results from the world health surveys. *The Lancet*. 2007;**370**(9590):851-858
- [43] Francesca C et al. OECD Health Policy Studies Help Wanted? Providing and Paying for Long-term Care. Vol. 2011. OECD Publishing; 2011
- [44] Bodenheimer T, Pham HH. Primary care: Current problems and proposed solutions. *Health Affairs*. 2010;**29**(5):799-805
- [45] United_Nations. World Population Ageing. 2015. Available from: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf [Accessed: 25 August 2019]
- [46] Yellapu V et al. Medical demographics in sub-Saharan Africa: Measuring temporal trends in emergency department visits among elderly patients. *International Journal of Academic Medicine*. 2018;**4**(3):331-332
- [47] WHO. Global Health and Aging. 2011. Available from: https://www.who.int/ageing/publications/global_health.pdf. [Accessed: 27 August 2019]
- [48] Stawicki SP et al. Comorbidity polypharmacy score and its clinical utility: A pragmatic practitioner's perspective. *Journal of Emergencies, Trauma, and Shock*. 2015;**8**(4):224
- [49] Murray CJ, Lopez AD, W.H. Organization. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020: Summary*. Geneva, Switzerland: World Health Organization; 1996
- [50] Kinsella K. Demographic dimensions of global aging. *Journal of Family Issues*. 2000;**21**(5):541-558
- [51] Jaul E, Barron J. Age-related diseases and clinical and public health implications for the 85 years old and over population. *Frontiers in Public Health*. 2017;**5**:335
- [52] United_Nations. *World Population Prospects*. 2019. Available from: <https://population.un.org/wpp/>. [Accessed: 27 August 2019]
- [53] CDC. *Healthy Aging in Action*. 2017. Available from: <https://www.cdc.gov/aging/pdf/healthy-aging-in-action508.pdf>. [Accessed: 27 August 2019]
- [54] Schwamm LH. Telehealth: Seven strategies to successfully implement disruptive technology and transform health care. *Health Affairs*. 2014;**33**(2):200-206
- [55] Bywood PT, Brown L, Raven M. *Improving the Integration of Mental Health Services in Primary Health Care at the Macro Level*. 2015.

Available from: https://dspace2.flinders.edu.au/xmlui/bitstream/handle/2328/36219/PIR_Integration%20of%20mental%20health%20services.pdf?sequence=1&isAllowed=y [Accessed: 10 August 2020]

[56] Ontario HQ. In-home care for optimizing chronic disease management in the community: An evidence-based analysis. Ontario Health Technology Assessment Series. 2013;**13**(5):1

[57] O'Donnell O. Access to health care in developing countries: Breaking down demand side barriers. *Cadernos De Saude Publica*. 2007;**23**:2820-2834

[58] Unnikrishnan D et al. Use of home telemedicine for critical illness rehabilitation: An Indian success story. *BMJ Case Reports*. 2019;**12**(2) bcr-2018-227779

[59] Free C et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: A systematic review and meta-analysis. *PLoS Medicine*. 2013;**10**(1):e1001363

[60] Kahn JG, Yang JS, Kahn JS. 'Mobile' health needs and opportunities in developing countries. *Health Affairs*. 2010;**29**(2):252-258

[61] Free C et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. *PLoS Medicine*. 2013;**10**(1):e1001362

[62] Robotham D et al. Using digital notifications to improve attendance in clinic: Systematic review and meta-analysis. *BMJ Open*. 2016;**6**(10):e012116

[63] McDonough KE, Davitt JK. It takes a village: Community practice, social work, and aging-in-place. *Journal of Gerontological Social Work*. 2011;**54**(5):528-541

[64] Narushima M. 'Payback time': Community volunteering among older adults as a transformative mechanism. *Ageing and Society*. 2005;**25**(4):567-584

[65] Martinez S. *Local Food Systems; Concepts, Impacts, and Issues*. Diane Publishing; 2010

[66] Santé OMDL et al. *Global Strategy for Infant and Young Child Feeding*. Geneva, Switzerland: World Health Organization; 2003

[67] Bernacki RE, Block SD. Communication about serious illness care goals: A review and synthesis of best practices. *JAMA Internal Medicine*. 2014;**174**(12):1994-2003

[68] Baxter R et al. Setting up a hospice and palliative care program at a university health network: Turning challenges into opportunities. In: Stawicki SP et al., editors. *Fundamentals of Leadership for Healthcare Professionals*. Vol. 2. Hauppauge, New York: NOVA Science Publishers; 2019

[69] Cohen MS et al. Patient frailty: Key considerations, definitions, and practical implications. *Challenges in Elder Care*. 2016:9

[70] Artiga S, Hinton E. *Beyond Health Care: The Role of Social Determinants in Promoting Health and Health Equity*. 2018. Available from: <https://www.kff.org/disparities-policy/issue-brief/beyond-health-care-the-role-of-social-determinants-in-promoting-health-and-health-equity/>. [Accessed: 12 December 2019]

[71] Marmot M et al. Closing the gap in a generation: Health equity through action on the social determinants of health. *The Lancet*. 2008;**372**(9650):1661-1669

[72] WHO. *Sixty-Fifth World Health Assembly: Decisions and List of Resolutions*. 2012. Available from:

- http://apps.who.int/gb/ebwha/pdf_files/WHA65/A65_DIV3-en.pdf. [Accessed: 28 December 2019]
- [73] Pega F, Veale JF. The case for the World Health Organization's commission on social determinants of health to address gender identity. *American Journal of Public Health*. 2015;**105**(3):e58-e62
- [74] Salas RN, Malina D, Solomon CG. Prioritizing health in a changing climate. *The New England Journal of Medicine*. 2019;**381**:773-774
- [75] Marchigiani R et al. Wind disasters: A comprehensive review of current management strategies. *International Journal of Critical Illness and Injury Science*. 2013;**3**(2):130
- [76] Blas E et al. The feasibility of measuring and monitoring social determinants of health and the relevance for policy and programme—A qualitative assessment of four countries. *Global Health Action*. 2016;**9**(1):29002
- [77] START. Global Terrorism Database. 2019. Available from: <https://www.start.umd.edu/gtd/>. [Accessed: 02 September 2019]
- [78] Kaniasty K, Norris FH. Social support in the aftermath of disasters, catastrophes, and acts of terrorism: Altruistic, overwhelmed, uncertain, antagonistic, and patriotic communities. *Bioterrorism: Psychological and Public Health Interventions*. 2004;**3**:200-229
- [79] Singer M, Hodge GD. *The War Machine and Global Health: A Critical Medical Anthropological Examination of the Human Costs of Armed Conflict and the International Violence Industry*. Lanham, MD: Rowman & Littlefield; 2010
- [80] Robertson AG, Robertson LJ. From asps to allegations: Biological warfare in history. *Military Medicine*. 1995;**160**(8):369-373
- [81] Christopher LGW et al. Biological warfare: A historical perspective. *JAMA*. 1997;**278**(5):412-417
- [82] Martin JW, Christopher GW, Eitzen EM. History of biological weapons: From poisoned darts to intentional epidemics. *Medical Aspects of Biological Warfare*. 2007:1-20
- [83] Leadbeater L, Inns R, Rylands J. Treatment of poisoning by soman. *Fundamental and Applied Toxicology*. 1985;**5**(6):S225-S231
- [84] Vale A, Marrs TC, Rice P. Chemical terrorism and nerve agents. *Medicine*. 2016;**44**(2):106-108
- [85] Watermeyer MJ et al. Essential lessons in a potential sarin attack disaster plan for a resource-constrained environment. *Disaster Medicine and Public Health Preparedness*. 2018;**12**(2):249-256
- [86] Fitzgerald GJ. Chemical warfare and medical response during world war I. *American Journal of Public Health*. 2008;**98**(4):611-625
- [87] Wattana M, Bey T. Mustard gas or sulfur mustard: An old chemical agent as a new terrorist threat. *Prehospital and Disaster Medicine*. 2009;**24**(1):19-29
- [88] Ghabili K et al. Mustard gas toxicity: The acute and chronic pathological effects. *Journal of Applied Toxicology*. 2010;**30**(7):627-643
- [89] Lim S-C et al. Acute lung injury after phosgene inhalation. *The Korean Journal of Internal Medicine*. 1996;**11**(1):87
- [90] Tewari-Singh N et al. Catalytic antioxidant AEOL 10150 treatment ameliorates sulfur mustard analog 2-chloroethyl ethyl sulfide-associated cutaneous toxic effects. *Free Radical Biology and Medicine*. 2014;**72**:285-295

- [91] Cevik Y et al. Mass casualties from acute inhalation of chlorine gas. *Southern Medical Journal*. 2009;**102**(12):1209-1213
- [92] Tomassoni AJ, French RN, Walter FG. Toxic industrial chemicals and chemical weapons: Exposure, identification, and management by syndrome. *Emergency Medicine Clinics*. 2015;**33**(1):13-36
- [93] Chaboo CS et al. Beetle and plant arrow poisons of the Ju'hoan and Haiom San peoples of Namibia (Insecta, Coleoptera, Chrysomelidae; Plantae, Anacardiaceae, Apocynaceae, Burseraceae). *ZooKeys*. 2016;**558**:9
- [94] Venkatesh S, Memish ZA. Bioterrorism—A new challenge for public health. *International Journal of Antimicrobial Agents*. 2003;**21**(2):200-206
- [95] Evans RG et al. Terrorism from a public health perspective. *The American Journal of the Medical Sciences*. 2002;**323**(6):291-298
- [96] Jansen H-J et al. Biological warfare, bioterrorism, and biocrime. *Clinical Microbiology and Infection*. 2014;**20**(6):488-496
- [97] Balali-Mood M, Moshiri M, Etemad L. Medical aspects of bioterrorism. *Toxicon*. 2013;**69**:131-142
- [98] Anderson PD, Bokor G. Bioterrorism: Pathogens as weapons. *Journal of Pharmacy Practice*. 2012;**25**(5):521-529
- [99] Christian MD. Biowarfare and bioterrorism. *Critical Care Clinics*. 2013;**29**(3):717-756
- [100] Anderson PD. Bioterrorism: Toxins as weapons. *Journal of Pharmacy Practice*. 2012;**25**(2):121-129
- [101] Schwenk M. Chemical warfare agents. Classes and targets. *Toxicology Letters*. 2018;**293**:253-263
- [102] Worek F et al. Toxicology of organophosphorus compounds in view of an increasing terrorist threat. *Archives of Toxicology*. 2016;**90**(9):2131-2145
- [103] Rodgers G Jr, Condurache C. Antidotes and treatments for chemical warfare/terrorism agents: An evidence-based review. *Clinical Pharmacology & Therapeutics*. 2010;**88**(3):318-327
- [104] Ilchmann K, Revill J. Chemical and biological weapons in the 'new wars'. *Science and Engineering Ethics*. 2014;**20**(3):753-767
- [105] Nef J. *Human Security and Mutual Vulnerability: The Global Political Economy of Development and Underdevelopment*. Ottawa, Ontario, Canada: IDRC; 1999
- [106] Cordesman AH. *Terrorism, Asymmetric Warfare, and Weapons of Mass Destruction: Defending the US Homeland*. Westport, CT: Greenwood Publishing Group; 2002
- [107] Khan AS, Levitt AM, Sage MJ. *Biological and Chemical Terrorism; Strategic Plan for Preparedness and Response: Recommendations of the CDC Strategic Planning Workgroup*. 2000
- [108] Papadimos TJ et al. Ethics of outbreaks position statement. Part 2: Family-centered care. *Critical Care Medicine*. 2018;**46**(11):1856-1860
- [109] Whitmee S et al. Safeguarding human health in the Anthropocene epoch: Report of the Rockefeller Foundation–lancet commission on planetary health. *The Lancet*. 2015;**386**(10007):1973-2028
- [110] Prüss-Üstün A, Corvalán C. Preventing disease through healthy environments: Towards an estimate of the environmental burden of disease. *SciELO Brasil*. 2006;**12**

- [111] Gakidou E et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: A systematic analysis for the global burden of disease study 2016. *The Lancet*. 2017;**390**(10100):1345-1422
- [112] Myers SS, Patz JA. Emerging threats to human health from global environmental change. *Annual Review of Environment and Resources*. 2009;**34**:223-252
- [113] IH Conference. Constitution of the World Health Organization. 1946. *Bulletin of the World Health Organization*. 2002;**80**(12):983
- [114] Horton R et al. From public to planetary health: A manifesto. *The Lancet*. 2014;**383**(9920):847
- [115] Corvalan C et al. *Ecosystems and Human Well-Being: Health Synthesis*. World Health Organization; 2005
- [116] PAHO-WHO. Health emergencies: Volcanic eruptions. 2019. Available from: <https://www.paho.org/disasters/index.php?Itemid=1171&lang=en>. [Accessed: 25 August 2019]
- [117] Doocy S, Daniels A, Dooling S. *The Human Impact of Volcanoes: A Historical Review of Events 1900-2009 and Systematic*.
- [118] *New Zealand Herald*. White Island volcano erupts in Bay of Plenty: 6 dead, 8 missing, 30 in hospital. 2019. Available from: https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12292240. [Accessed: 10 December 2019]
- [119] Baxter PJ et al. Human survival in volcanic eruptions: Thermal injuries in pyroclastic surges, their causes, prognosis and emergency management. *Burns*. 2017;**43**(5):1051-1069
- [120] Hlodversdottir H et al. Long-term health effects of the Eyjafjallajökull volcanic eruption: A prospective cohort study in 2010 and 2013. *BMJ Open*. 2016;**6**(9):e011444
- [121] Carlsen HK et al. Health effects following the Eyjafjallajökull volcanic eruption: A cohort study. *BMJ Open*. 2012;**2**(6):e001851
- [122] Nguyen HT et al. High prevalence of cognitive impairment among students near mount Merapi: A case study. *Journal of Exercise Rehabilitation*. 2018;**14**(4):573
- [123] Gissurardóttir ÓS et al. Mental health effects following the eruption in Eyjafjallajökull volcano in Iceland: A population-based study. *Scandinavian Journal of Public Health*. 2019;**47**(2):251-259
- [124] Hlodversdottir H et al. Long-term health of children following the Eyjafjallajökull volcanic eruption: A prospective cohort study. *European Journal of Psychotraumatology*. 2018;**9**(sup 2):1442601
- [125] Warsini S et al. Post-traumatic stress disorder among survivors two years after the 2010 Mount Merapi volcano eruption: A survey study. *Nursing & Health Sciences*. 2015;**17**(2):173-180
- [126] Shruti V et al. Metal concentrations in recent ash fall of Popocatepetl volcano 2016, Central Mexico: Is human health at risk? *Ecotoxicology and Environmental Safety*. 2018;**162**:324-333
- [127] Gudmundsson MT et al. Eruptions of Eyjafjallajökull volcano, Iceland. *Eos, Transactions American Geophysical Union*. 2010;**91**(21):190-191
- [128] Budd L et al. A fiasco of volcanic proportions? Eyjafjallajökull and the closure of European airspace. *Mobilities*. 2011;**6**(1):31-40

- [129] Adey P, Anderson B. Anticipation, materiality, event: The Icelandic ash cloud disruption and the security of mobility. *Mobilities*. 2011;**6**(1):11-20
- [130] DHS. Build a kit: Basic disaster supplies kit. 2019. Available from: <https://www.ready.gov/kit>. [Accessed: 29 December 2019]
- [131] CDC. Volcanoes. 2018. Available from: <https://www.cdc.gov/disasters/volcanoes/index.html>. [Accessed: 25 August 2019]
- [132] Warsini S et al. Living through a volcanic eruption: Understanding the experience of survivors as a phenomenological existential phenomenon. *International Journal of Mental Health Nursing*. 2016;**25**(3):206-213
- [133] Steinle S et al. The effectiveness of respiratory protection worn by communities to protect from volcanic ash inhalation. Part II: Total inward leakage tests. *International Journal of Hygiene and Environmental Health*. 2018;**221**(6):977-984
- [134] Galea K et al. Health interventions in volcanic eruptions—Community wearability assessment of respiratory protection against volcanic ash from Mt Sinabung, Indonesia. *International Journal of Environmental Research and Public Health*. 2018;**15**(11):2359
- [135] Fonseca MG et al. Effects of climate and land-use change scenarios on fire probability during the 21st century in the Brazilian Amazon. *Global Change Biology*. 2019;**25**(9):2931-2946
- [136] Romano CS. Brazilian Government policies towards the Amazon rain Forest: From a developmental ideology to an environmental consciousness. *Colorado Journal of International Environmental and Law Policy*. 1999;**10**:65
- [137] Rubenstein ES. It's Complicated: The Role of Land in Global Warming.
- [138] Reis E, Margulis S. Options for slowing Amazon jungle clearing. *Global Warming: Economic Policy Responses*. 1991:335-375
- [139] Tollefson J. Climate: Counting carbon in the Amazon. *Nature News*. 2009;**461**(7267):1048-1052
- [140] Rockström J et al. Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*. 2009;**14**:32
- [141] Spratt D, Sutton P. *Climate Code Red*. Collingwood, Australia: Friends of the Earth; 2008
- [142] da Silva SS et al. Dynamics of forest fires in the southwestern Amazon. *Forest Ecology and Management*. 2018;**424**:312-322
- [143] Escobar H. Amazon Fires Clearly Linked to Deforestation, Scientists Say. *American Association for the Advancement of Science*; 2019
- [144] Frankenberg E, McKee D, Thomas D. Health consequences of forest fires in Indonesia. *Demography*. 2005;**42**(1):109-129
- [145] Duclos P, Sanderson LM, Lipsett M. The 1987 forest fire disaster in California: Assessment of emergency room visits. *Archives of Environmental Health: An International Journal*. 1990;**45**(1):53-58
- [146] Henderson SB, Johnston FH. Measures of forest fire smoke exposure and their associations with respiratory health outcomes. *Current Opinion in Allergy and Clinical Immunology*. 2012;**12**(3):221-227
- [147] Sorensen C, Garcia-Trabanino R. A new era of climate medicine—Addressing heat-triggered renal disease. *New England Journal of Medicine*. 2019;**381**(8):693-696
- [148] Johnson RJ, Wesseling C, Newman LS. Chronic kidney disease

of unknown cause in agricultural communities. *New England Journal of Medicine*. 2019;**380**(19):1843-1852

[149] Jimenez CAR et al. Fructokinase activity mediates dehydration-induced renal injury. *Kidney International*. 2014;**86**(2):294-302

[150] Haines A, Ebi K. The imperative for climate action to protect health. *New England Journal of Medicine*. 2019;**380**(3):263-273

[151] Shi H et al. Modeling study of the air quality impact of record-breaking Southern California wildfires in December 2017. *Journal of Geophysical Research: Atmospheres*. 2019

[152] Tedim F et al. 1.1 Extreme wildfires: A true challenge for societies. In: *Extreme Wildfire Events and Disasters: Root Causes and New Management Strategies*. Amsterdam, Netherlands: Elsevier; 2019. pp. 3-29

[153] Dowdy AJ et al. Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports*. 2019;**9**(1):1-11

[154] Lim E-P et al. Australian hot and dry extremes induced by weakenings of the stratospheric polar vortex. *Nature Geoscience*. 2019;**12**(11):896-901

[155] Di Virgilio G et al. Climate change increases the potential for extreme wildfires. *Geophysical Research Letters*. 28 Jul 2019;**46**(14):8517-8526

[156] Cascio WE. Wildland fire smoke and human health. *Science of the Total Environment*. 2018;**624**:586-595

[157] Fann N et al. The health impacts and economic value of wildland fire episodes in the US: 2008-2012. *Science of the Total Environment*. 2018;**610**:802-809

[158] Degallier N et al. Toward an early warning system for dengue prevention:

Modeling climate impact on dengue transmission. *Climatic Change*. 2010;**98**(3-4):581-592

[159] Guojing Y, Kun Y, Xiaonong Z. Assessment models for impact of climate change on vector-borne diseases transmission. *Advances in Climate Change Research*. 2010;**4**:259-264

[160] Haque MA et al. Use of traditional medicines to cope with climate-sensitive diseases in a resource poor setting in Bangladesh. *BMC Public Health*. 2014;**14**(1):202

[161] Coleman CN, Lurie N. Emergency medical preparedness for radiological/nuclear incidents in the United States. *Journal of Radiological Protection*. 2012;**32**(1):N27

[162] Coleman CN et al. Public health and medical preparedness for a nuclear detonation: The nuclear incident medical enterprise. *Health Physics*. 2015;**108**(2):149

[163] Bentz JA, Blumenthal DJ, Potter BA. It's all about the data: Responding to international chemical, biological, radiological, and nuclear incidents. *Bulletin of the Atomic Scientists*. 2014;**70**(4):57-68

[164] Tompson A et al. On the evaluation of groundwater contamination from underground nuclear tests. *Environmental Geology*. 2002;**42**(2-3):235-247

[165] Malone RC et al. Nuclear winter: Three-dimensional simulations including interactive transport, scavenging, and solar heating of smoke. *Journal of Geophysical Research: Atmospheres*. 1986;**91**(D1):1039-1053

[166] Alex A, Philip S, Vikas Y, Manish G, Charles B, Nicholas C, Gregory D, et al. *Fundamentals of Medical Radiation Safety: Focus on Reducing Short-Term and Long-Term Harmful*

Exposures, Vignettes in Patient Safety - Volume 4. Stawicki SP, Firstenberg MS, editor. IntechOpen. 13th April 2019. DOI: 10.5772/intechopen.85689. Available from: <https://www.intechopen.com/books/vignettes-in-patient-safety-volume-4/fundamentals-of-medical-radiation-safety-focus-on-reducing-short-term-and-long-term-harmful-exposure>

[167] Hipkin J, Paynter R. Radiation exposures to the workforce from naturally occurring radioactivity in industrial processes. *Radiation Protection Dosimetry*. 1991;**36**(2-4):97-100

[168] Sakamoto-Hojo ET. Lessons from the accident with ¹³⁷Cesium in Goiania, Brazil: Contributions to biological dosimetry in case of human exposure to ionizing radiation. *Mutation Research, Genetic Toxicology and Environmental Mutagenesis*. 2018;**836**:72-77

[169] Anjos RM et al. Goiania: 12 years after the ¹³⁷Cs radiological accident. *Radiation Protection Dosimetry*. 2002;**101**(1-4):201-204

[170] Collins DL, de Carvalho AB. Chronic stress from the Goiania ¹³⁷Cs radiation accident. *Behavioral Medicine*. 1993;**18**(4):149-157

[171] Pastel RH. Radiophobia: Long-term psychological consequences of Chernobyl. *Military Medicine*. 2002;**167**(suppl_1):134-136

[172] Haynes V, Bojcun M. The Chernobyl Disaster. 1988. Available from: https://inis.iaea.org/search/search.aspx?orig_q=RN:20002675 [Accessed 10 August 2020]

[173] Gauntt R, et al. Fukushima Daiichi accident study (status as of April 2012). Sandia Report Sand. 2012. p. 6173

[174] Evrard O et al. Evolution of radioactive dose rates in fresh sediment deposits along coastal rivers draining

Fukushima contamination plume. *Scientific Reports*. 2013;**3**:3079

[175] Møller AP, Barnier F, Mousseau TA. Ecosystems effects 25 years after Chernobyl: Pollinators, fruit set and recruitment. *Oecologia*. 2012;**170**(4):1155-1165

[176] Tateda Y, Tsumune D, Tsubono T. Simulation of radioactive cesium transfer in the southern Fukushima coastal biota using a dynamic food chain transfer model. *Journal of Environmental Radioactivity*. 2013;**124**:1-12

[177] Rissanen K, Rahola T. Radiocesium in lichens and reindeer after the Chernobyl accident. *Rangifer*. 1990:55-61

[178] Buck EH. Effects of Radiation from Fukushima Daiichi on the US Marine Environment. DIANE Publishing; 2011

[179] Ten Hoeve JE, Jacobson MZ. Worldwide health effects of the Fukushima Daiichi nuclear accident. *Energy & Environmental Science*. 2012;**5**(9):8743-8757

[180] Chino M et al. Preliminary estimation of release amounts of ¹³¹I and ¹³⁷Cs accidentally discharged from the Fukushima Daiichi nuclear power plant into the atmosphere. *Journal of Nuclear Science and Technology*. 2011;**48**(7):1129-1134

[181] Fry F, Clarke R, O'riordan M. Early estimates of UK radiation doses from the Chernobyl reactor. *Nature*. 1986;**321**(6067):193

[182] Bromet EJ. Mental health consequences of the Chernobyl disaster. *Journal of Radiological Protection*. 2012;**32**(1):N71

[183] Marples DR. The Social Impact of the Chernobyl Disaster. London, UK: Macmillan Press; 1988

- [184] Yamashita S, Suzuki S. Risk of thyroid cancer after the Fukushima nuclear power plant accident. *Respiratory Investigation*. 2013;**51**(3):128-133
- [185] Takamura N et al. Radiation and risk of thyroid cancer: Fukushima and Chernobyl. *The Lancet Diabetes & Endocrinology*. 2016;**4**(8):647
- [186] Evangelidou N et al. Global and local cancer risks after the Fukushima nuclear power plant accident as seen from Chernobyl: A modeling study for radiocaesium (^{134}Cs & ^{137}Cs). *Environment International*. 2014;**64**:17-27
- [187] Tsubokura M et al. Limited internal radiation exposure associated with resettlements to a radiation-contaminated homeland after the Fukushima Daiichi nuclear disaster. *PLoS One*. 2013;**8**(12):e81909
- [188] Von Solms R, Van Niekerk J. From information security to cyber security. *Computers & Security*. 2013;**38**:97-102
- [189] Luna R et al. Cyber threats to health information systems: A systematic review. *Technology and Health Care*. 2016;**24**(1):1-9
- [190] Perakslis ED. Cybersecurity in health care. *The New England Journal of Medicine*. 2014;**371**(5):395-397
- [191] Zhang H, Nakamura T, Sakurai K. Security and trust issues on digital supply chain. In: 2019 IEEE International Conference on Dependable, Autonomic and Secure Computing, International Conference on Pervasive Intelligence and Computing, International Conference on Cloud and Big Data Computing, International Conference on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech); IEEE. 2019
- [192] Blessman D. Protecting your software supply chain. *Risk Management*. 2019;**66**(1):10-11
- [193] Wirth A. The times they are a-Changin': Part two. *Biomedical Instrumentation & Technology*. 2018;**52**(3):236-240
- [194] Radanliev P, De Roure C, Cannady S, Montalvo RM, Nicolescu R, Huth M. Economic impact of IoT cyber risk-analysing past and present to predict the future developments in IoT risk analysis and IoT cyber insurance. In: *Living in the Internet of Things: Cybersecurity of the IoT-2018*. London: Institution of Engineering and Technology; 2018. DOI: 10.1049/cp.2018.0003
- [195] Strielkina A, Uzun D, Kharchenko V. Modelling of healthcare IoT using the queueing theory. In: 2017 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS); IEEE. 2017
- [196] Strielkina A, Kharchenko V, Uzun D. Availability models for healthcare IoT systems: Classification and research considering attacks on vulnerabilities. In: 2018 IEEE 9th International Conference on Dependable Systems, Services and Technologies (DESSERT); IEEE. 2018
- [197] Patyal M et al. Multi-layered defense architecture against ransomware. *International Journal of Business and Cyber Security*. 2017;**1**(2):52-64
- [198] Chernyshev M, Zeadally S, Baig Z. Healthcare data breaches: Implications for digital forensic readiness. *Journal of Medical Systems*. 2019;**43**(1):7
- [199] Pope J. Ransomware: Minimizing the risks. *Innovations in Clinical Neuroscience*. 2016;**13**(11-12):37
- [200] Richardson R, North MM. Ransomware: Evolution, mitigation and prevention. *International Management Review*. 2017;**13**(1):10

- [201] E. Order. Executive Order—Improving Critical Infrastructure Cybersecurity. 2013
- [202] Kohane IS et al. Building national electronic medical record systems via the world wide web. *Journal of the American Medical Informatics Association*. 1996;3(3):191-207
- [203] Neuhaus C, Polze A, Chowdhury MM. Survey on Healthcare IT Systems: Standards, Regulations and Security. *Universitätsverlag Potsdam*; 2011
- [204] Braunstein ML. *Health Informatics in the Cloud*. New York, NY: Springer Science & Business Media; 2012
- [205] Cerrato P, Halamka J. *The Transformative Power of Mobile Medicine: Leveraging Innovation, Seizing Opportunities and Overcoming Obstacles of mHealth*. London, UK: Academic Press; 2019
- [206] Mercuri RT. The HIPAA-potamus in health care data security. *Communications of the ACM*. 2004;47(7):25-28
- [207] Zhang K et al. Security and privacy for mobile healthcare networks: From a quality of protection perspective. *IEEE Wireless Communications*. 2015;22(4):104-112
- [208] AHA. Integration of Cyber and Physical Security Functions and Technology. 2018. Available from: <https://www.aha.org/education-events/integration-cyber-and-physical-security-functions-and-technology>.
- [209] AHA. Cybersecurity Must be a Priority for Everyone. 2017. Available from: <https://www.aha.org/news/blog/2017-12-04-cybersecurity-must-be-priority-everyone>. [Accessed: 14 December 2019]
- [210] Velasco E et al. Social media and internet-based data in global systems for public health surveillance: A systematic review. *The Milbank Quarterly*. 2014;92(1):7-33
- [211] Stawicki SP, Firstenberg MS, Papadimos TJ. The growing role of social media in international health security: The good, the bad, and the ugly. In: Masys AJ, Ricardo I, Miguel RO, editors. *Global Health Security: Recognizing Vulnerabilities, Creating Opportunities*. Cham, Switzerland: Springer; 2019
- [212] Reina-Ortiz M et al. State of the globe: Ebola outbreak in the western world: Are we really ready? *Journal of Global Infectious Diseases*. 2015;7(2):53
- [213] Oyeyemi SO, Gabarron E, Wynn R. Ebola, twitter, and misinformation: A dangerous combination? *BMJ*. 2014;349:g6178
- [214] Zeng J. Contesting Rumours on Social Media during Acute Events: The 2014 Sydney Siege and 2015 Tianjin Blasts. *Queensland University of Technology*; 2018
- [215] Austin G. *African Economic Development and Colonial Legacies*. Vol. 1. Institut de Hautes Études Internationales et du Développement; 2010
- [216] Quadrelli R, Peterson S. The energy–climate challenge: Recent trends in CO₂ emissions from fuel combustion. *Energy Policy*. 2007;35(11):5938-5952
- [217] Tucker M. Carbon dioxide emissions and global GDP. *Ecological Economics*. 1995;15(3):215-223
- [218] Watts N et al. The 2018 report of the lancet countdown on health and climate change: Shaping the health of nations for centuries to come. *The Lancet*. 2018;392(10163):2479-2514
- [219] Loladze I. Hidden shift of the ionome of plants exposed to elevated

CO₂ depletes minerals at the base of human nutrition. *elife*. 2014;**3**:e02245

[220] Newland K. *Climate Change and Migration Dynamics*. Washington, DC: Migration Policy Institute; 2011

[221] Khasnis AA, Nettleman MD. Global warming and infectious disease. *Archives of Medical Research*. 2005;**36**(6):689-696

[222] Scheffran J, Battaglini A. Climate and conflicts: The security risks of global warming. *Regional Environmental Change*. 2011;**11**(1):27-39

[223] Hufnagel L, Brockmann D, Geisel T. Forecast and control of epidemics in a globalized world. *Proceedings of the National Academy of Sciences*. 2004;**101**(42):15124-15129

[224] Saker L et al. *Globalization and Infectious Diseases: A Review of the Linkages*. Geneva: World Health Organization; 2004

[225] Ruiz Estrada MA et al. *Is Terrorism, Poverty, and Refugees the Dark Side of Globalization?* 2018

[226] Moghaddam FM. *How globalization spurs terrorism: The lopsided benefits of "one world" and why that fuels violence*. Praeger Security International. 2008

[227] Nassar JR. *Globalization and Terrorism: The Migration of Dreams and Nightmares*. Lanham, Maryland: Rowman & Littlefield Publishers; 2009

[228] Rossen I et al. Accepters, fence sitters, or rejecters: Moral profiles of vaccination attitudes. *Social Science & Medicine*. 2019;**224**:23-27

[229] Shah J et al. *New age technology and social media: Adolescent psychosocial implications and the need for protective measures*.

Current Opinion in Pediatrics. 2019;**31**(1):148-156

[230] Nelson DH et al. The Bell tolls for homeopathy: Time for change in the training and practice of North American Naturopathic Physicians. *Journal of Evidence-Based Integrative Medicine*. 2019;**24** 2515690X18823696

[231] Stawicki TT et al. From "pearls" to "tweets:" how social media and web-based applications are revolutionizing medical education. *International Journal of Academic Medicine*. 2018;**4**(2):93

[232] Seneviratne SI et al. The many possible climates from the Paris Agreement's aim of 1.5C warming. *Nature*. 2018;**558**(7708):41

[233] Kriegler E et al. What does the 2 C target imply for a global climate agreement in 2020? The LIMITS study on Durban platform scenarios. *Climate Change Economics*. 2013;**4**(04):1340008

[234] Dansgaard W et al. Evidence for general instability of past climate from a 250-kyr ice-core record. *Nature*. 1993;**364**(6434):218

[235] Dai A. Increasing drought under global warming in observations and models. *Nature Climate Change*. 2013;**3**(1):52

[236] Petit J-R et al. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature*. 1999;**399**(6735):429

[237] Howden SM et al. Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences*. 2007;**104**(50):19691-19696

[238] Seidl R et al. Forest disturbances under climate change. *Nature Climate Change*. 2017;**7**(6):395

[239] McDowell NG, Allen CD. Darcy's law predicts widespread forest mortality

- under climate warming. *Nature Climate Change*. 2015;**5**(7):669
- [240] La Sorte FA, Fink D. Projected changes in prevailing winds for transatlantic migratory birds under global warming. *Journal of Animal Ecology*. 2017;**86**(2):273-284
- [241] McMichael AJ, Bennett CM. Global environmental change and human health. In: *The Ashgate Research Companion to the Globalization of Health*. Routledge; 2016. pp. 119-138
- [242] Emanuel K, Sundararajan R, Williams J. Hurricanes and global warming: Results from downscaling IPCC AR4 simulations. *Bulletin of the American Meteorological Society*. 2008;**89**(3):347-368
- [243] Gosling SN, Arnell NW. A global assessment of the impact of climate change on water scarcity. *Climatic Change*. 2016;**134**(3):371-385
- [244] Portier CJ et al. A human health perspective on climate change: A report outlining the research needs on the human health effects of climate change. In: *Environmental Health Perspectives*. National Institute of Environmental Health. North Carolina: Research Triangle; 2017
- [245] Sachs JD. Toward an international migration regime. *American Economic Review*. 2016;**106**(5):451-455
- [246] Plante C, Anderson CA. Global warming and violent behavior. *APS Observer*. 2017;**30**(2):1-2
- [247] Schär C et al. The role of increasing temperature variability in European summer heatwaves. *Nature*. 2004;**427**(6972):332
- [248] Zolina O et al. Changing structure of European precipitation: Longer wet periods leading to more abundant rainfalls. *Geophysical Research Letters*. 2010;**37**(6):1-5
- [249] Lee JE et al. Land use change exacerbates tropical South American drought by sea surface temperature variability. *Geophysical Research Letters*. 2011;**38**(19):1-6.
- [250] Dai A. Drought under global warming: A review. *Wiley Interdisciplinary Reviews: Climate Change*. 2011;**2**(1):45-65
- [251] Kita SMJ, Raleigh CH. Environmental migration and international political security. In: *Routledge Handbook of Environmental Displacement and Migration*. Routledge in Association with GSE Research; 2018. pp. 356-369
- [252] Solanki SK et al. Unusual activity of the sun during recent decades compared to the previous 11,000 years. *Nature*. 2004;**431**(7012):1084
- [253] Bhattacharya AB et al. Energetic particles propagation: A probable link between solar activity and terrestrial climate. *Journal of Science, Engineering, Health and Management (JSEHM)*. 2017:42
- [254] Svensmark H. Cosmic rays, clouds and climate. *Europhysics News*. 2015;**46**(2):26-29
- [255] Frigo E et al. Effects of solar activity and galactic cosmic ray cycles on the modulation of the annual average temperature at two sites in southern Brazil. *Annales Geophysicae*. 3 Apr 2018;**36**(2):555-564
- [256] Lam MM, Tinsley BA. Solar wind-atmospheric electricity-cloud microphysics connections to weather and climate. *Journal of Atmospheric and Solar-Terrestrial Physics*. 2016;**149**:277-290
- [257] Markel H. How the Tylenol Murders of 1982 Changed the Way we Consume Medication. 2014. Available

from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/109703/TylenolMurders_Markel.pdf?se
[Accessed: 10 Aug 2020]

[258] McKay C, Scharman EJ. Intentional and inadvertent chemical contamination of food, water, and medication. *Emergency Medicine Clinics*. 2015;**33**(1):153-177

[259] MacIntyre CR et al. Converging and emerging threats to health security. *Environment Systems and Decisions*. 2018;**38**(2):198-207

[260] Government_Publishing_Office. Title 18: Crimes and criminal procedures. 2010. Available from: <https://www.govinfo.gov/content/pkg/USCODE-2010-title18/pdf/USCODE-2010-title18-partI-chap65-sec1365.pdf>. [Accessed: 30 August 2019]

[261] Bix L et al. Examining the conspicuousness and prominence of two required warnings on OTC pain relievers. *Proceedings of the National Academy of Sciences*. 2009;**106**(16):6550-6555

[262] Osterholm MT, Schwartz J. Living terrors: What America needs to know to survive the coming bioterrorist catastrophe. *Delta*; 2007

[263] Evans NG, Selgelid MJ. Biosecurity and open-source biology: The promise and peril of distributed synthetic biological technologies. *Science and Engineering Ethics*. 2015;**21**(4):1065-1083

[264] Manolis AS. Carcinogenic impurities in generic Sartans: An issue of authorities' control or a problem with generics? *Rhythmos*. 2019;**14**(2):23-26

[265] Shanley A. After Valsartan Recalls, Regulators Grapple with Nitrosamine Contamination in APIs. 2018

[266] FDA. Levothyroxine Sodium Product Information. 2015. Available

from: <https://www.fda.gov/drugs/postmarket-drug-safety-information-patients-and-providers/levothyroxine-sodium-product-information>. [Accessed: 29 August 2019]

[267] Tamargo J, Rosano G. Low-quality of some generic medicinal products represents a matter for growing concern. *European Heart Journal-Cardiovascular Pharmacotherapy*. 1 July 2020;**6**(3):176-187

The Impact of Systems of Care on International Health Security

Nicholas Reis and James Cipolla

Abstract

International health security (IHS) prioritizes cross-border threats to nations such as epidemics, bioterrorism, and climate change. In the modern era, however, the leading causes of mortality are not infectious. Cardiovascular disease (CVD) is the leading cause of death worldwide. Over three-quarters of CVD deaths take place in low-income countries, illustrating a disparity in care. Traumatic injury also remains one of the leading causes of morbidity and mortality worldwide, placing a particularly heavy burden upon countries with limited resources. Cerebrovascular disease and acute stroke syndromes are major causes of mortality and disability worldwide. Programs leading to timely revascularization have proven to be the most powerful predictor of disease outcomes. The health of women and children is vital to creating a healthy world. The impact of neonatal resuscitation programs on mortality has been a major force in advancing international health security. Finally, the establishment of emergency medical services (EMS) systems has been shown to improve the health of communities in both high- and low-income nations. In order to address health security on a global scale, government authorities and public health institutions must incorporate access to modern systems of care addressing the major determinants of health and primary causes of mortality.

Keywords: health security, international, trauma, ATLS, ACLS, EMS, NRP, stroke

1. Introduction

International health security is a new and evolving concept within the global health community. Despite apparent differences in understanding and use of the concept in different settings, international health security, in its most general sense, prioritizes cross-border threats to the modern and future achievements of nations such as the emergence of disease epidemics, bioterrorism, and climate change [1]. The gravity of these threats and their potential impact on people the world over has fostered greater health diplomacy between nations. There is greater cooperation and health information sharing now than in any other time in history, allowing for an evaluation of the impact contemporary systems of care may have on international health security. While global public health achievements in large part stem from greater ability to prevent and control the spread of infectious disease, this is not the sole determinate of global health and life expectancy. In the modern era, the leading causes of mortality worldwide are not infectious (**Table 1**). Cardiovascular disease is, in fact, the number one cause of mortality worldwide, inclusive of all ages and demographics. Cerebrovascular disease is the second most common cause of death. Out-of-hospital cardiac arrest, traumatic injury, and peripartum

complications leading to neonatal death continue to have a significant impact on global mortality. Emergency medical services and programs such as ATLS, Advanced Cardiac Life Support (ACLS), and the Neonatal Resuscitation Program (NRP) were created to help deliver essential knowledge and skills to communities with low resources and increased disease burden. In this chapter, we will review the impact of these programs and initiatives aimed at improving health outcomes globally.

2. Methods

An organized procedure was followed to ensure a high quality review of the literature regarding the subject of interest. First, a comprehensive search of peer-reviewed journals was completed based on a wide range of key terms including, but not limited to, “global health,” “health security,” and “health systems.” Databases searched included PubMed, Ovid, and Google Scholar. Next, a search of websites such as the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the National Institutes of Health (NIH) was conducted for policy and review statements on major threats to health security and leading cause of mortality worldwide. Based on these findings, further literature review was conducted using key terms such as “Trauma,” “Cardiovascular Disease,” “Stroke,” “Maternal Health,” “ATLS,” “ACLS,” “EMS,” and “NRP.” Literature review continued with articles identified as having potential for further review from the references sections of articles previously collected. The literature search ultimately generated 109 articles referenced in this review, which were published between 1980 and 2019. The collective information gained from this literature review was synthesized to identify the impact of programs and initiatives aimed at improving outcomes from the greatest threats to health security. These were organized into sections and are presented as examples of the extent to which these systems of care impact health security internationally.

3. Trauma systems

Traumatic injury is a disease without boundaries; it is one of the leading causes of morbidity and mortality worldwide and places a particularly heavy burden upon countries with limited resources. Road injuries alone killed 1.4 million people in 2016, about three-quarters (74%) of whom were men and boys [3]. Despite greater knowledge of injury causes and prevention, the growing global population, traffic, and urbanization cause morbidity and mortality secondary to trauma to remain a major health concern worldwide. Ensuring timely access to advanced trauma care as an international health security measure requires an organized network of prehospital emergency care and a standardized system of trauma care that can be replicated and delivered to patients in rural community hospitals and major academic tertiary care centers alike.

One of the largest initiatives in improving trauma care to-date has been the Advanced Trauma Life Support (ATLS) course. This training program was developed in 1978 by the American College of Surgeons following the tragic event of an orthopedic surgeon piloting his plane, who crashed into a Nebraska cornfield with his family, killing his wife and severely injuring his three children [4]. Insufficiency in the system of emergency medical care was recounted by this surgeon, who called for a system change to improve the care for trauma victims everywhere. ATLS focuses on the initial stabilization and resuscitation of the trauma patient, referencing the “Golden Hour” as the most important, as 30% of all trauma deaths occur

Rank	0-4 years	5-14 years	15-29 years	30-44 years	45-59 years	≥60 years	All ages
1	Lower respiratory infections 1,890,008	Childhood cluster diseases 219,434	HIV/AIDS 707,277	HIV/AIDS 1,178,856	Ischemic heart disease 1,043,978	Ischemic heart disease 5,812,863	Ischemic heart disease 7,153,056
2	Diarrheal diseases 1,577,891	Road traffic injuries 130,835	Road traffic injuries 302,208	Tuberculosis 390,004	Cerebrovascular diseases 623,099	Cerebrovascular diseases 4,685,722	Cerebrovascular diseases 5,489,591
3	Low birth weight 1,149,168	Lower respiratory infections 127,782	Self-inflicted injuries 251,806	Road traffic injuries 285,457	Tuberculosis 400,708	COPD 2,396,739	Lower respiratory infections 3,764,415
4	Malaria 1,098,446	HIV/AIDS 108,090	Tuberculosis 245,818	Ischemic heart disease 231,340	HIV/AIDS 390,267	Lower respiratory infections 1,395,611	HIV/AIDS 2,818,762
5	Childhood cluster diseases 1,046,177	Drowning 86,327	Interpersonal violence 216,169	Self-inflicted injuries 230,490	COPD 309,726	Cancers of respiratory system 927,889	COPD 2,743,509
6	Birth asphyxia and birth trauma 729,066	Tropical cluster diseases 35,454	Lower respiratory infections 92,522	Interpersonal violence 165,796	Cancers of respiratory system 261,860	Diabetes 749,977	Diarrheal diseases 1,766,447
7	HIV/AIDS 370,706	Fires 33,046	Fires 90,845	Cerebrovascular diseases 124,417	Cirrhosis of the liver 250,208	Hypertensive heart disease 732,262	Tuberculosis 1,605,063
8	Congenital heart disease 223,569	Tuberculosis 32,762	Drowning 87,499	Cirrhosis of the liver 100,101	Road traffic injuries 221,776	Stomach cancer 605,395	Childhood cluster diseases 1,359,548
9	Protein energy malnutrition 138,197	Protein energy malnutrition 30,763	War 71,680	Lower respiratory infections 98,232	Self-inflicted injuries 189,215	Tuberculosis 495,199	Cancers of respiratory system 1,238,417
10	STDs (except HIV) 76,871	Meningitis 30,694	Hypertensive heart disease 61,711	Poisoning 81,930	Stomach cancer 185,188	Colon or rectal cancer 476,902	Malaria 1,221,432

Table 1. Most common causes of death worldwide by age group, 2002 (adapted from WHO prehospital trauma care systems) [2].

within 60 minutes of injury [5]. Despite a paucity of data on the effect ATLS has on trauma mortality, existing evidence supports its practice as a means of decreasing mortality and improving systems of care globally [6, 7].

Over 90% of deaths related to injury occur in low-income countries where the availability of prevention programs, emergency services, and centers capable of prompt, advanced resuscitation is limited. The majority of these deaths are caused by road traffic injuries [8]. Establishing early advanced trauma care is essential to decreasing global morbidity and mortality due to trauma and is, in part, accomplished with the dissemination of trauma education programs [9]. Studies have shown that as the number of ATSL-trained professional increases, the rates of preventable and potentially preventable deaths decreases (**Figure 1**) [10].

One study of trauma-related deaths before and after the implementation of focused trauma education courses in the capital of Rwanda, including ATLS, found the mortality of severely injured patients decreased significantly in the 6 months following their initiation [7]. Another study reported improved management of trauma patients by practitioners from countries throughout East, Central, and Southern Africa after institution of a primary trauma care course [11]. In the Netherlands, the introduction of ATLS resulted in a significantly improved trauma outcome in the first hour after admission [12]. A study on the impact of mandatory ATLS training on processes of care in rural America found improvement after categorization of trauma centers [6]. Improvement in trauma patient outcomes has also been reported after ATLS training in Trinidad and Tobago [13].

Since its inception, ATLS has gone through several iterations. Its principles have become standard of care in over 50 countries worldwide, with over 1 million physicians trained since the mid-1990s [14–16]. ATLS has developed into a global resuscitation program, with confirmed results in terms of improved patient outcomes, processes of care, and teaching.

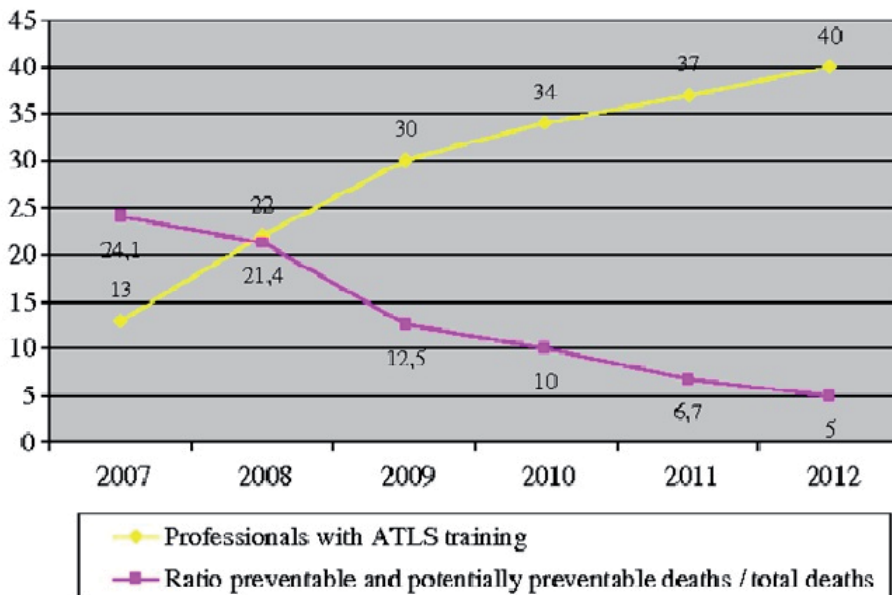


Figure 1. Change in mortality over time with increasing number of ATLS-trained providers (adapted from Navarro et al. [10]).

4. Cardiovascular care

Cardiovascular disease (CVD) is by far the leading cause of death worldwide. An estimated 17.9 million people died from CVD in 2016, representing 31% of all global deaths, 85% of which are due to heart attack and stroke [3, 17]. Over three-quarters of CVD deaths take place in low-income countries, illustrating a disparity in care and the need for further resource allocation and education. Despite the global burden of CVD, there have been remarkable advances in treatment and prevention. The field of resuscitation has been evolving for more than two centuries with the American Heart Association (AHA) formally endorsing cardiopulmonary resuscitation (CPR) in 1963 [18].

Basic life support (BLS) and advanced cardiac life support (ACLS) guidelines have evolved over the past several decades based on a combination of scientific evidence and expert consensus. The AHA and European Resuscitation Council developed the most recent ACLS Guidelines in 2010 using a comprehensive review of resuscitation literature performed by the International Liaison Committee on Resuscitation (ILCOR). These were updated in 2015 and 2018 [19–26]. The efficacy of these guidelines is well borne out in the literature with clear reductions in in-hospital and out-of-hospital mortality when the most critical interventions (e.g., defibrillation, CPR, and rapid transport to an advanced care) are initiated early (Figure 2) [24, 27–31].

Numerous large-scale randomized clinical trials have demonstrated the benefit of timely interventions as well, including antiplatelet therapy, thrombolysis, and cardiac catheterization [17, 32]. Results from these trials have been incorporated into guidelines for inpatient and outpatient cardiac care internationally [33, 34].

Despite these well-established guidelines for the management of ACS, there are still strong differences with regard to the epidemiology, diagnosis, and treatment of patients with ACS, leading to diverging morbidity and mortality rates throughout the globe [17]. Reasons for such differences among different global populations are multifactorial and include differences in population genetics, access to care, diet, socioeconomic status, and treatment modalities employed regionally (i.e., invasive vs. non-invasive strategies) [35, 36]. To address these disparities, much work has been done to universalize treatment protocols by bringing systems of care to areas most in need.

Stent for Life (SFL), a European Association of Percutaneous Cardiovascular Interventions (EAPCI) and Congress of the European Association of Percutaneous Cardiovascular Interventions (EuroPCR) coalition, was established in 2008 as a non-profit international network of national cardiac societies and partnering organizations. The mission of SFL was to address inequalities in ST-elevation acute

	No. (%)							
	2005	2006	2007	2008	2009	2010	2011	2012
Neurologically intact survival	587	768	1194	1294	1495	1543	1677	1710
Defibrillation								
Bystander only	6 (1.0)	34 (4.4)	69 (5.8)	117 (9.0)	143 (9.6)	169 (11.0)	186 (11.1)	217 (12.7)
EMS only	431 (73.4)	560 (72.9)	811 (67.9)	845 (65.3)	974 (65.2)	963 (62.4)	955 (56.9)	959 (56.1)
Combined ^a	5 (0.9)	8 (1.0)	33 (2.8)	47 (3.6)	66 (4.4)	86 (5.6)	101 (6.0)	100 (5.8)
Bystander chest compression	315 (53.7)	438 (57.0)	721 (60.4)	835 (64.5)	974 (65.2)	1050 (68.0)	1125 (67.1)	1179 (68.9)

Figure 2.

Exposure to prehospital bystander interventions among patients who achieved neurologically intact survival. EMS = emergency medical services; ^apatients received both bystander and EMS defibrillation (adapted from Nakahara et al. [27]).

myocardial infarction (STEMI) patients' access to a life-saving revascularization treatment throughout Europe.

Effective from 2008 to 2016 in 23 countries, mainly in Europe, this initiative significantly improved the delivery of guideline-compliant therapy and patient access to primary percutaneous coronary intervention (p-PCI), thereby reducing mortality and morbidity in patients suffering from acute myocardial infarction (AMI) [37, 38]. Since 2017, the Stent—Save a Life Initiative (SSLI) was founded as the global extension and continuation of Stent for Life. The SSLI works to identify regions and countries with an unmet medical need in the optimal treatment of ACS and implement an action program to increase patient access to primary PCI where indicated.

The advancement of international health security is seen in the work of these and similar organizations which work to identify opportunities and challenges in building systems of care in emerging countries, such as India, China, South Africa, and Mexico, where CAD mortality is increasing and becoming a significant healthcare problem [39–42]. Geographic mapping and situational analyses have shown that adherence to STEMI guidelines is influenced by many factors and varies from country to country, from region to region, and no one model fits all communities. Greater understanding of system-level barriers and unique challenges in the regional context will facilitate the development of more effective strategies for improving the treatment and preventing CVD globally.

5. Cerebrovascular disease

Cerebrovascular disease and acute stroke syndromes are a leading cause of mortality and disability worldwide. According to the Global Burden of Disease Study published in December, 2018 the estimated lifetime risk of stroke for a 25 year old during their remaining lifespan is 25% [43]. Stroke is the third leading cause of death and first leading cause of major disability in North America. Over the last several decades developed countries have experienced reductions in stroke-related morbidity and mortality [44]. Mortality from stroke has decreased by 60% in the United States alone, but remains the fifth leading cause of death [45–47]. For most developed countries, this experience has been similar. Over the last 20 years, high-income countries have experienced an age-standardized decrease in incidence, mortality and disease burden (as measured by disability-adjusted life year loss rates) of 13, 37, and 21%, respectively [48, 49]. Nonetheless, Stroke accounts for almost 5% of all disability-adjusted life-years and 10% of all deaths worldwide [50].

While progress has been made in stroke care in developed countries, the global experience of cerebrovascular disease is less encouraging. In 2013, 6.4 million deaths (11.8% of all global deaths) were a result of stroke [51]. Stroke remains the third leading cause of years-of-potential-life lost worldwide [52]. Between 1990 and 2010, the incidence of ischemic stroke increased by 37% and that of hemorrhagic stroke increased by 47%; the total number of deaths attributable to ischemic and hemorrhagic stroke increased by 20% over that same period [48]. By 2030 there could be as many as 12 million stroke deaths, 70 million stroke survivors, and >200 million disability-adjusted life years lost from stroke each year [44]. Not surprisingly, the majority of the burden of disease is borne by low- and middle income countries at the center of the global stroke epidemic [53]. While high-income, developed countries have been experiencing significant declines in stroke incidence in recent years, undeveloped, low-income countries have experienced increases in incidence by as much as 100% [54]. The substantial regional and country-level variation in stroke disease, with hotspots of particularly high-stroke incidence, mortality, and morbidity in Eastern Europe, East and Southeast Asia, Central Africa, and Oceania

has become known as the “Global Stroke Belt” [55]. The most affected countries in the global stroke belt have a >10-fold higher age-standardized stroke mortality rate than the least affected countries [56].

There have been significant advances in stroke care in recent years. Timely revascularization has been by far the most powerful predictor of improved outcome in patients with acute ischemic stroke [57]. Given the time-sensitive nature of therapeutic interventions and the specialized care required by those affected, regional systems of care have evolved in different forms to provide patients the best functional outcomes possible. The emergence of advanced imaging modalities and endovascular interventions have had a significant impact on the organization of acute stroke care, as communities strive to deliver the most up-to-date, evidence-based treatments effectively.

Evidence shows that organized care within specialized stroke units is associated with better quality of care and reduced rates of death and disability [58]. There is significant variation, however, within and between countries in access to stroke care and the organizational models of such care [59]. In several countries, acute stroke services are being centralized into “hub and spoke” systems in which hospital providing different levels of care work together to create a centralized system in which all patients with acute ischemic stroke are taken to specialized centers, rather than the nearest hospital [60]. Research suggests that in countries where such models exist (e.g., the United States, Canada, the Netherlands, Denmark, and Australia), there is greater provision of evidence-based therapies by increasing access to specialist care and thrombolysis [61–63]. Other countries, such as the United Kingdom, have found decreases in mortality and hospital length-of-stay where hyperacute stroke services were centralized to a small number of highly specialized, high-volume centers [64]. In other countries, such as Greece, a centrally administered rotation system for 24-hour on-call services exists for specialized stroke care [65].

In the United States (U.S.), regionalization of care around specialized centers played a large role in stroke dropping from the third to the fifth most common cause of death [55]. In the year 2000, the Brain Attack Coalition recommended the establishment of primary stroke centers (PSCs). Primary Stroke Center certification recognizes hospitals that meet standards to support better outcomes for stroke care. Studies from the American Heart Association/American Stroke Association Get With The Guidelines-Stroke Program have demonstrated that PSC certification improves many key process measures of stroke care [66].

Studies have shown that not only do hospitals with PSC certification experience lower mortality rates but also the mortality benefit appears to be independent of hospital size or time since certification (**Figure 3**) [67, 68]. This suggests that the process of obtaining certification in advanced stroke care alone may improve outcomes, regardless of hospital size. Since 2012, hospitals may become certified as comprehensive stroke centers (CSCs), another designation based on the Brain Attack Foundation’s recommendations for establishing systems of stroke care which requires an ability to provide more-complex services, including 24/7 availability of endovascular procedures. According to a large national study of stroke centers in the U.S., CSCs were significantly better at providing prompt acute treatment (i.e., thrombolysis and endovascular clot retrieval) for patients with acute ischemic stroke, but in-hospital mortality was similar between hospital settings [69]. The fact that less technically sophisticated centers provided non-inferior care to larger, more advanced centers has significant implications. For communities with evolving systems of care and in nations where resources are limited, a focus on providing established medical therapies to the most number of people in the most timely manner possible may be more beneficial than investing in expensive advanced technologies.

	Designated Stroke Center (n = 15,297) No. %	Non-Designated Hospital (n = 15,650) No. %	Adjusted Mortality Difference (95% CI) ^a	P-Value
1 day	90 (0.6)	134 (0.9)	-0.3 (-0.6 to 0.0)	0.04
7 day	665 (4.3)	842 (5.4)	-1.3 (-2.1 to -0.6)	0.001
30 day	1543 (10.1)	1951 (12.5)	-2.5 (-3.6 to -1.4)	<0.001
1 Year	3412 (22.3)	4067 (26)	-3 (-4.4 to -1.5)	<0.001

Figure 3.

Mortality at designated stroke centers and nondesignated hospitals. CI = confidence interval; ^anegative values indicate lower mortality rates at designated vs. nondesignated hospitals (adapted from Xian et al. [67]).

6. Neonatal resuscitation

The health of women and children is vital to creating a healthy world. Ensuring access to appropriate perinatal care is vital to international health security. Despite great progress, there are still too many mothers and children dying—mostly from causes that could have been prevented. Every day, there are approximately 800 deaths from preventable causes related to pregnancy and childbirth, 99% of which occur in developing countries. Despite decreasing rates of childhood mortality worldwide, neonatal deaths account for nearly half of all deaths in children less than 5 years old [70]. Intrapartum-related events such as birth asphyxia contribute to approximately one-quarter of neonatal deaths, many of which can be decreased by simple resuscitative and newborn care maneuvers. Neonatal deaths now comprise ~45% of all childhood deaths in children less than 5 years old, resulting in 2.7 million lives lost each year [71].

The challenge of delivering neonatal resuscitative interventions is complicated by the fact that childbirth often occurs outside of healthcare facilities; up to 60% in some parts of the world [72]. Implementation of properly performed neonatal resuscitation remains low in countries with the highest neonatal mortality rates [72]. Adequate basic neonatal resuscitation can prevent many intrapartum deaths. Studies suggest that an additional 20–40% of lives would be saved with the institution of basic neonatal resuscitation where it is needed most [73, 74].

Understanding the impact that neonatal resuscitation delivered by trained healthcare workers can have on mortality is essential to improving international health security. Implementation of neonatal resuscitation programs has been shown to decrease intrapartum stillbirth rates and early neonatal mortality. Skilled birth attendance and newborn resuscitation are evidence-based interventions directed at the moment when the lifetime risk for mortality is highest [73, 74].

The American Academy of Pediatrics released the Neonatal Resuscitation Program (NRP) in 1997, the first standardized training program for neonatal resuscitation of its kind. The NRP is an educational program that translates the science of resuscitation into practice. The initial goals of the NRP were to promote evidence-based care for newborns and to ensure the presence of at least one professional trained in neonatal resuscitation at every delivery in the United States (US) [75]. Hands-on learning with mannequins and a simple, transportable program structure led to widespread adoption outside the US. The use of NRP has spread globally with countries adapting the program to function within the context of their own healthcare environments [76]. NRP continues to be a driving force for the development of initiatives to reduce newborn mortality by promoting an action-oriented approach that trains a variety of providers, aids in the acquisition of resuscitation equipment, and promotes the

importance of newborn health to proper authorities [77]. Implementation of NRP in various countries has resulted in a reduction in birth asphyxia-related mortality, in addition to increased use of bag-mask ventilation in newborn resuscitation [78, 79].

Drawbacks of the NRP, however, exist, and are primarily related to its complexity, which necessitates training in well-resourced settings. This has also been shown to result in inadequate skills retention after training when the learner does not practice neonatal resuscitation regularly [80]. These and other challenges to the adoption of NRP in low-resource settings may lead to the assumption that resuscitation cannot be accomplished without advanced equipment and facilities [81]. Research over the last two decades, however, has shown that over 98% of babies respond with spontaneous breathing after basic resuscitation, including drying, warmth, stimulation, and bag-mask ventilation [72, 82].

Thus, NRP courses taught in resource-limited settings have been modified to focus on the initial steps of resuscitation while omitting discussion of more complex interventions such as intubation, medications, and umbilical line placement. Adaptations of NRP have improved both educational outcomes and skills when used to teach providers in low-resource settings [79, 83, 84]. They also have led to decreases in perinatal mortality. In a multinational randomized trial of 62,366 births in rural communities, utilization of a modified NRP and newborn care package resulted in a 30% reduction in still birth rates [85]. Such experiences demonstrate that low-resource settings require a curriculum specifically designed and targeted for their needs.

With the goal of equipping caretakers in all practice settings with the basic knowledge and skills necessary to perform adequate neonatal resuscitation, a task force organized by the American Academy of Pediatrics set out to develop a simplified, standardized curriculum based on NRP. The result was the Helping Babies Breathe (HBB) program, which became available in 2010. The HBB curriculum is portable, low cost, and teaches a simpler algorithm than NRP, focusing on stimulation, drying, clearing the airway, and bag-mask ventilation. Instead of spending time evaluating a baby's condition, interventions begin immediately with sequential evaluation of crying, breathing, and heart rate. Elements of essential newborn care are incorporated into the curriculum, including encouragement of breastfeeding, cleanliness, and warmth at delivery. The World Health Organization (WHO) released guidelines on basic newborn resuscitation in 2012, which were largely consistent with the recommendations and action plan of HBB [86].

Educational evaluations of HBB in developing countries have shown the course to be well received since their dissemination workshops in HBB have been shown to improve knowledge and skills in basic neonatal resuscitation immediately after training [87–91]. Most encouraging for the further spread of the program have been studies evaluating differences in performance based on the type of provider. While physicians perform better in pre-workshop assessments of both knowledge and skills of basic resuscitation, after HBB training, nurses perform as well in simulation as physicians [89, 91]. This and similar evidence support the training of doctors, nurses, midwives, and all others involved in newborn care. This is vital as, globally, midwives and other non-physicians care for the majority of deliveries.

Since the introduction of HBB, over 300,000 providers have been trained in 77 countries [92]. Fifty-two countries have established nationally led programs. Analysis of 80,000 births after HBB training demonstrated a 47% reduction in early neonatal deaths and a 24% reduction in fresh stillbirth rates (**Figure 4**) [94].

Studies in developing countries where HBB was adopted have shown a decrease in perinatal mortality and in stillbirth rates [93, 95]. A systematic review evaluating whether the implementation of a standardized formal neonatal resuscitation training program in low- and middle-income countries improved neonatal outcomes

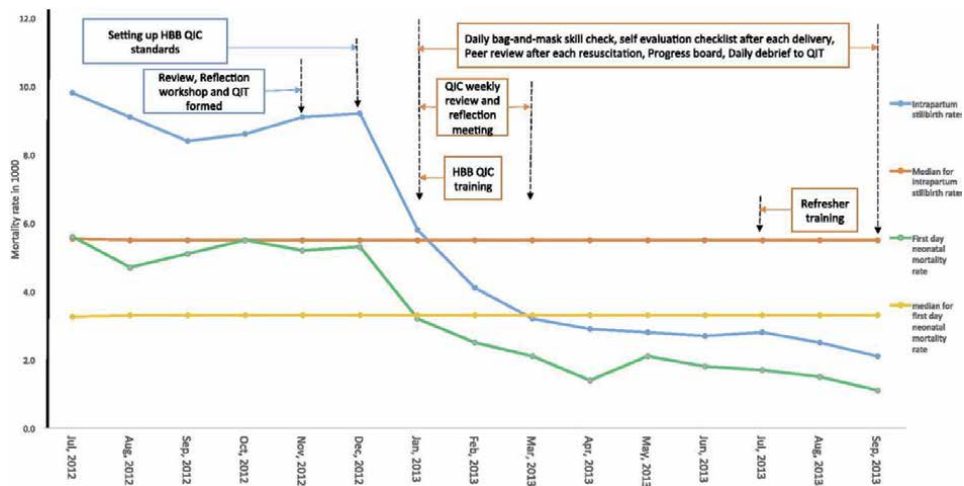


Figure 4. Stillbirth and intrapartum mortality rates overtime during implementation of HBB in a Nepalese tertiary care center. QIC = quality improvement cycle; QIT = quality improvement team (adapted from Kc et al. [93]).

found that early neonatal mortality (first week of life) decreased by 15% and reduction of 28-day mortality by 45% [96].

On a global scale, many successes have been achieved with the implementation of neonatal resuscitation: decreased neonatal mortality, decreased still birth rates, and increased use of alternative providers. Despite the successes of implementation of neonatal resuscitation education, training providers in and of itself is insufficient to close the gaps in quality of newborn care. An estimated two-thirds of the world's 2.7 million newborn deaths may be prevented with basic pre- and postnatal care [97]. While there may be successes to celebrate, there is still much work to be done to improve newborn care and reduce neonatal mortality globally.

7. Emergency medical services

An emergency medical service can be described as a comprehensive system, which provides the arrangements of personnel, facilities, and equipment for the effective, coordinated, and timely delivery of health and safety services to victims of sudden illness or injury [98]. The goal of EMS is to provide timely health care for out-of-hospital medical emergencies in order to prevent unnecessary mortality or long-term morbidity [2].

Timely access to healthcare in an emergency situation is a fundamental component of health security. Prompt provision of prehospital emergency care coupled with rapid movement of the ill and injured to a health-care facility can save lives, reduce the incidence of short-term disability, and markedly improve long-term outcomes. The World Health Organization regards EMS system as an integral part of any effective and functional health care system [99]. In developed nations, emergency medical service (EMS) has evolved into a key link in the chain of survival for those suffering out-of-hospital illness or injury, and contributes significantly to the overall function of a healthcare system and health of a society. The birth and evolution of emergency medical services has, however, been a very slow process and has occurred on different timelines around the world.

Although modern EMS initially developed during Napoleon's time to aid injured soldiers, few major changes occurred in EMS until the 1960s. The adaptation of prehospital care and transport principles from the military to the civilian arena

accelerated after the Vietnam War, as returning veterans helped raise awareness of the disparities in care. By the end of the conflict, gunshot victims had better chances of survival in the jungles of Vietnam than they had in the streets of major cities across America. Between 1960 and 1970, a number of medical, historical, and social forces converged, leading to the development of a more structured EMS system in the United States and abroad [100].

Since the 1970s, emergency health care delivery has evolved from two different models with different philosophies and distinct features, referred to as the Anglo-American and Franco-German models of care [2]. Although the categorical distinctions between these two models were more obvious leading up to the twentieth century, modern EMS systems around the world have evolved along one of these two frameworks while adopting various components of the other.

The Franco-German model is based on a “stay and stabilize” philosophy where advanced medical care is brought to the patient. Emergency services are run by physicians who respond to patient’s homes or the scene of an accident where they provide advanced care. Patients are either stabilized and provided follow-up directions or are transported to the hospital for admission. This results in fewer EMS transports and fewer patients being seen and treated in emergency departments. This approach to prehospital care, where EMS is an extension of the hospital, is widely implemented in continental Europe (e.g., France, Germany, Greece, Malta, and Austria) where emergency medicine is a young specialty.

By contrast, the Anglo-American model of EMS care is based on a “scoop and run” philosophy [101]. The objective in this model is to rapidly bring patients to the hospital with less time spent on prehospital treatment and interventions. Here, EMS services are allied with public safety services such as fire or police departments rather than public health services or hospitals [102]. Specialized emergency medical technicians (EMTs) and paramedics provide direct patient care with remote physician oversight. In countries where this model prevails, emergency medicine is well developed and recognized as a separate medical specialty [103]. Patients are transported to emergency departments (EDs) where the majority of evaluation and treatment is begun. Patients are then either discharged or admitted to the wards for further treatment. Examples of countries utilizing this model include the United States, Canada, New Zealand, and Australia.

While both models of EMS share a similar focus for the severely ill and injured (i.e., stabilization and transport), it is the delivery of non-life-threatening care where the greatest difference is found. Whereas the Franco-German model places more emphasis on treating patients in their homes and avoiding transport when possible, the Anglo-American model transports the majority of patients for evaluation in an emergency department [104]. Given the significant differences in these systems, much comparative research has been done on patient outcome and cost-effectiveness between the two models. Outcomes, however, are difficult to interpret because of the disparate nature of each model. Each operates in a different context with different goals. The lack of unified standards makes direct comparison difficult and there is no evidence that one model is better than the other [105–107].

Unfortunately, to this day, the capacity to provide the most basic level of prehospital emergency care is lacking in many countries around the world. While EMS providers have developed an extended role in dealing with medical emergencies and have access to advanced clinical technologies in some countries, in others their education and training is much more limited due to a lack of funding, resources, and organizational guidance. Regardless of how simple or sophisticated a prehospital care system may be, the essential elements of an effective model are not outside the capabilities of developing nations. These elements, shown to decrease morbidity and mortality, include prompt communication and activation of the prehospital

emergency response system, immediate system response, and simultaneous treatment and transport to formal medical care [99]. It is important to note that there is little evidence that advanced prehospital interventions benefit more than a small subset of the most critically ill or injured. Studies have shown that the majority of cases require treatment within the skill set of responders trained only in basic life support [102]. This has major implications for nations with limited resources, where advanced life support materials and programs may harm a system by diverting precious resources from less glamorous, but more effective measures that benefit a larger number of people. Ultimately, the model chosen for creating and administering an EMS system best suited to a particular demographic will be influenced by regional resources, culture and values, but should always be the result of local and national governments working together toward a common goal of greater health security [108].

8. Future concerns

In an increasingly interconnected world, the potential for threats to international health security such as pandemics, bioterrorism, and radionuclear exposure are of increasing concern. The research and design of medical countermeasures in the form of vaccines, antimicrobials, therapeutics, and diagnostics that address the public health and medical consequences of chemical, biological, radiological, and nuclear events is an area of active research and development. In 2014, the United States in partnership with international organizations and nearly 30 partner countries launched the Global Health Security Agenda (GHSA) to accelerate progress to improve prevention, detection, and response capabilities for public health emergencies [109]. The GHSA calls for improved global access to medical countermeasures and establishes as a target the development of national policy frameworks for sending and receiving medical countermeasures from and to international partners during public health emergencies. International health countermeasures such as vaccines, antidotes, and decontamination supplies are now stockpiled by several countries to protect their own populations and by international organizations such as the WHO for the benefit of the international community (typically those with limited resources). Much work remains, however. During the H1N1 influenza pandemic in 2009, legal, regulatory, logistical, and funding barriers slowed the spread of vaccine and revealed how implementing health security measures on a global scale remains a significant challenge [109]. While imperfect in its implementation, the network established by the GHSA continues to evolve and help combat future threats to international health security. Greater efforts are needed to develop a framework to deploy medical countermeasures internationally, thus increasing global capacity to respond to public health emergencies.

9. Conclusion

The concept of health security means different things to different people. In developed nations, the concept is that of addressing threats to public health such as the spread of disease and bioterrorism. In developing nations, threats to health also include access to care and modern therapies. In order to address health security on a global scale, government authorities and public health institutions must incorporate access to modern systems of care addressing the major determinants of health and primary causes of mortality into the focus of international health security. In this chapter, we have discussed how organized systems of care stand to improve the

health of communities on a global scale. With greater emphasis on establishing these and other systems in developing countries, greater health security can be brought to communities that need it most.

Abbreviations

ACLS	advanced cardiac life support
ACS	acute coronary syndrome
AHA	American Heart Association
AMI	acute myocardial infarction
ATLS	Advanced Trauma Life Support
BLS	basic life support
CDC	Centers for Disease Control and Prevention
CPR	cardiopulmonary resuscitation
CSC	comprehensive stroke center
CVD	cardiovascular disease
EAPCI	European Association of Percutaneous Cardiovascular Interventions
ED	emergency department
EMS	emergency medical services
EMT	emergency medical technician
EuroPCR	Congress of the European Association of Percutaneous Cardiovascular Interventions
GHSA	Global Health Security Agenda
HBB	Helping Babies Breathe
IHS	international health security
ILCOR	International Liaison Committee on Resuscitation
NIH	National Institutes for Health
NRP	Neonatal Resuscitation Program
PSC	Primary Stroke Center
p-PCI	primary percutaneous coronary intervention
SFL	Stent for Life
STEMI	ST-elevation acute myocardial infarction
SSLI	Stent-Save a Life Initiative
WHO	World Health Organization

Author details


Nicholas Reis^{1*} and James Cipolla^{1,2}

1 Division of Trauma, Surgical Critical Care, and Emergency Surgery, St. Luke's University Health Network, Bethlehem, Pennsylvania, USA

2 Temple/St. Luke's School of Medicine, University of Pennsylvania School of Medicine, Bethlehem, Pennsylvania, USA

*Address all correspondence to: nicholas.reis@sluhn.org

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Aldis W. Health security as a public health concept: A critical analysis. *Health Policy and Planning*. 2008;**23**(6):369-375
- [2] Al-Shaqsi S. Models of international emergency medical service (EMS) systems. *Oman Medical Journal*. 2010;**25**(4):320-323. Available from: <http://www.omjournal.org>
- [3] World Health Organization, Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. 2018
- [4] Styner JK. The birth of Advanced Trauma Life Support (ATLS). *The Surgeon*. 2006;**4**(3):163-165
- [5] Soreide K et al. Epidemiology and contemporary patterns of trauma deaths: Changing place, similar pace, older face. *World Journal of Surgery*. 2007;**31**(11):2092-2103
- [6] Olson CJ et al. Influence of trauma system implementation on process of care delivered to seriously injured patients in rural trauma centers. *Surgery*. 2001;**130**(2):273-279
- [7] Petroze RT et al. Can focused trauma education initiatives reduce mortality or improve resource utilization in a low-resource setting? *World Journal of Surgery*. 2015;**39**(4):926-933. Available from: <https://www.springer.com/journal/268>
- [8] WHO. World Report on Road Traffic Injury Prevention. WHO; 2004
- [9] Mock C et al. Strengthening trauma systems globally: The essential trauma care project. *The Journal of Trauma*. 2005;**59**(5):1243-1246
- [10] Navarro S, Montmany S, Rebasa P, Colilles C, Palliser A. Impact of ATLS training on preventable and potentially preventable deaths. *World Journal of Surgery*. 2014;**38**(9):2273-2278
- [11] Ologunde R et al. Do trauma courses change practice? A qualitative review of 20 courses in East, Central and Southern Africa. *Injury*. 2017;**48**(9):2010-2016
- [12] van Olden GD et al. Clinical impact of advanced trauma life support. *The American Journal of Emergency Medicine*. 2004;**22**(7):522-525
- [13] Ali J et al. Cognitive and attitudinal impact of the Advanced Trauma Life Support program in a developing country. *The Journal of Trauma*. 1994;**36**(5):695-702
- [14] van Vugt AB. 'Advanced trauma life support' in Netherlands. *Nederlands Tijdschrift voor Geneeskunde*. 2000;**144**(44):2093-2097
- [15] Scharplatz D, Sutter PM, Ummenhofer W. ATLS (advanced trauma life support) in Switzerland. *Swiss Surgery*. 2000;**6**(6):343-346
- [16] Rastad J, Lindebert T. "Advanced trauma life support" in Sweden. A flying start for trauma education. *Läkartidningen*. 1996;**93**(30-31):2660-2661
- [17] Kampfer J et al. Long-term outcomes after acute myocardial infarction in countries with different socioeconomic environments: An international prospective cohort study. *BMJ Open*. 2017;**7**(8):e012715
- [18] DeBard ML. The history of cardiopulmonary resuscitation. *Annals of Emergency Medicine*. 1980;**9**(5):273-275
- [19] Field JM et al. Part 1: Executive summary: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and

emergency cardiovascular care. *Circulation*. 2010;**122**(18 Suppl 3): S640-S656

[20] Hazinski MF et al. Part 1: Executive summary: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation*. 2010;**122**(16 Suppl 2): S250-S275

[21] Neumar RW et al. Part 1: Executive summary: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;**132**(18 Suppl 2): S315-S367

[22] Link MS et al. Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;**132**(18 Suppl 2):S444-S464

[23] Nolan JP et al. European Resuscitation Council Guidelines for Resuscitation 2010: Section 1. Executive summary. *Resuscitation*. 2010;**81**(10):1219-1276

[24] Monsieurs KG et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 1. Executive summary. *Resuscitation*. 2015;**95**:1-80

[25] Soar J et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult Advanced Life Support. *Resuscitation*. 2015;**95**:100-147

[26] Soar J et al. 2018 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. *Resuscitation*. 2018;**133**:194-206

[27] Nakahara S et al. Association of bystander interventions with

neurologically intact survival among patients with bystander-witnessed out-of-hospital cardiac arrest in Japan. *JAMA*. 2015;**314**(3):247-254

[28] Rea TD et al. Temporal trends in sudden cardiac arrest: A 25-year emergency medical services perspective. *Circulation*. 2003;**107**(22):2780-2785

[29] Aufderheide TP et al. Implementing the 2005 American Heart Association guidelines improves outcomes after out-of-hospital cardiac arrest. *Heart Rhythm*. 2010;**7**(10):1357-1362

[30] Malta Hansen C et al. Association of bystander and first-responder intervention with survival after out-of-hospital cardiac arrest in North Carolina, 2010-2013. *JAMA*. 2015;**314**(3):255-264

[31] McEvoy MD et al. The effect of adherence to ACLS protocols on survival of event in the setting of in-hospital cardiac arrest. *Resuscitation*. 2014;**85**(1):82-87

[32] Ribeiro HB, Lemos PA. Seeking actual benchmarks in acute coronary syndromes for European countries: Insights from the EURHOBOP registry. *Heart*. 2014;**100**(15):1147-1148

[33] Ibanez B et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). *European Heart Journal*. 2018;**39**(2):119-177

[34] Hamm CW et al. ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. The Task Force for the management of acute coronary syndromes (ACS) in patients presenting without persistent ST-segment elevation

of the European Society of Cardiology (ESC). *Giornale italiano di cardiologia (Rome)*. 2012;**13**(3):171-228

[35] Orlandini A et al. Outcomes of patients in clinical trials with ST-segment elevation myocardial infarction among countries with different gross national incomes. *European Heart Journal*. 2006;**27**(5):527-533

[36] Jakobsen L et al. Dimensions of socioeconomic status and clinical outcome after primary percutaneous coronary intervention. *Circulation. Cardiovascular Interventions*. 2012;**5**(5):641-648

[37] Kristensen SD et al. Implementation of primary angioplasty in Europe: Stent for Life initiative progress report. *EuroIntervention*. 2012;**8**(1):35-42

[38] Laut KG, Kaifoszova Z, Kristensen SD. Status of Stent for Life initiative across Europe. *Journal of Cardiovascular Medicine (Hagerstown, Md.)*. 2011;**12**(12):856-859

[39] Gupta R. Burden of coronary heart disease in India. *Indian Heart Journal*. 2005;**57**(6):632-638

[40] Huo Y. Current status and development of percutaneous coronary intervention in China. *Journal of Zhejiang University Science B*. 2010;**11**(8):631-633

[41] Schamroth C. Management of acute coronary syndrome in South Africa: Insights from the ACCESS (acute coronary events—A multinational survey of current management strategies) registry. *Cardiovascular Journal of Africa*. 2012;**23**(7):365-370

[42] Velazquez Monroy O et al. Morbidity and mortality by ischemic heart disease and stroke in Mexico. 2005. *Archivos de Cardiología de México*. 2007;**77**(1):31-39

[43] Feigin VL et al. Global, regional, and country-specific lifetime risks of stroke, 1990 and 2016. *The New England Journal of Medicine*. 2018;**379**(25):2429-2437

[44] Feigin VL et al. Global burden of stroke and risk factors in 188 countries, during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet Neurology*. 2016;**15**(9):913-924

[45] Ten great public health achievements—United States, 1900-1999. *MMWR. Morbidity and Mortality Weekly Report*. 1999;**48**(12):241-243

[46] Ten great public health achievements—United States, 2001-2010. *MMWR. Morbidity and Mortality Weekly Report*. 2011;**60**(19):619-623. Available from: <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6019a5.htm>

[47] Kochanek KD et al. Mortality in the United States, 2013. *NCHS Data Brief*. 2014;(178):1-8

[48] Krishnamurthi RV et al. Global and regional burden of first-ever ischaemic and haemorrhagic stroke during 1990-2010: Findings from the Global Burden of Disease Study 2010. *The Lancet Global Health*. 2013;**1**(5):e259-e281

[49] Bennett DA et al. The global burden of ischemic stroke: Findings of the GBD 2010 study. *Global Heart*. 2014;**9**(1):107-112. Available from: <https://pubmed.ncbi.nlm.nih.gov/25432120/>

[50] Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017;**390**(10100):1151-1210. Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(17\)32152-9/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32152-9/fulltext)

[51] Global, regional, and national age-sex specific all-cause and cause-specific

- mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;**385**(9963):117-171
- [52] Wang H et al. Age-specific and sex-specific mortality in 187 countries, 1970-2010: A systematic analysis for the global burden of disease study 2010. *Lancet*. 2012;**380**(9859):2071-2094
- [53] Lopez AD et al. Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. *Lancet*. 2006;**367**(9524):1747-1757
- [54] Feigin VL et al. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: A systematic review. *Lancet Neurology*. 2009;**8**(4):355-369
- [55] Kim AS, Cahill E, Cheng NT. Global stroke belt: Geographic variation in stroke burden worldwide. *Stroke*. 2015;**46**(12):3564-3570
- [56] Johnston SC, Mendis S, Mathers CD. Global variation in stroke burden and mortality: Estimates from monitoring, surveillance, and modelling. *Lancet Neurology*. 2009;**8**(4):345-354
- [57] Rha JH, Saver JL. The impact of recanalization on ischemic stroke outcome: A meta-analysis. *Stroke*. 2007;**38**(3):967-973. Available from: <https://www.ahajournals.org/doi/full/10.1161/01.str.0000258112.14918.24>, <https://www.ahajournals.org/doi/abs/10.1161/01.str.0000258112.14918.24>
- [58] Organised inpatient (stroke unit) care for stroke. *Cochrane Database of Systematic Reviews*. 2007;(4):Cd000197
- [59] de Sousa DA et al. Access to and delivery of acute ischaemic stroke treatments: A survey of national scientific societies and stroke experts in 44 European countries. *European Stroke Journal*. 2019;**4**(1):13-28
- [60] Higashida R et al. Interactions within stroke systems of care: A policy statement from the American Heart Association/American Stroke Association. *Stroke*. 2013;**44**(10):2961-2984
- [61] Prabhakaran S et al. Prehospital triage to primary stroke centers and rate of stroke thrombolysis. *JAMA Neurology*. 2013;**70**(9):1126-1132
- [62] Swartz RH et al. A system-based intervention to improve access to hyperacute stroke care. *The Canadian Journal of Neurological Sciences*. 2017;**44**(5):475-482
- [63] Douw K, Nielsen CP, Pedersen CR. Centralising acute stroke care and moving care to the community in a Danish health region: Challenges in implementing a stroke care reform. *Health Policy*. 2015;**119**(8):1005-1010
- [64] Morris S et al. Impact and sustainability of centralising acute stroke services in English metropolitan areas: Retrospective analysis of hospital episode statistics and stroke national audit data. *BMJ*. 2019;**364**:l1
- [65] Theofanidis D, Fountouki A. An overview of stroke infrastructure, network, and nursing services in contemporary Greece. *The Journal of Neuroscience Nursing*. 2017;**49**(4):247-250
- [66] LaBresh KA et al. Hospital treatment of patients with ischemic stroke or transient ischemic attack using the "Get With The Guidelines" program. *Archives of Internal Medicine*. 2008;**168**(4):411-417
- [67] Xian Y et al. Association between stroke center hospitalization for acute ischemic stroke and mortality. *JAMA*. 2011;**305**(4):373-380
- [68] Man S, Schold JD, Uchino K. Impact of stroke center certification on mortality after ischemic stroke: The

- Medicare cohort from 2009 to 2013. *Stroke*. 2017;**48**(9):2527-2533
- [69] Man S et al. Comparison of acute ischemic stroke care and outcomes between comprehensive stroke centers and primary stroke centers in the United States. *Circulation. Cardiovascular Quality and Outcomes*. 2018;**11**(6):e004512
- [70] Kamath-Rayne BD et al. Neonatal resuscitation in global health settings: An examination of the past to prepare for the future. *Pediatric Research*. 2017;**82**(2):194-200
- [71] Gaffey MF, Das JK, Bhutta ZA. Millennium development goals 4 and 5: Past and future progress. *Seminars in Fetal & Neonatal Medicine*. 2015;**20**(5):285-292
- [72] Wall SN et al. Reducing intrapartum-related neonatal deaths in low- and middle-income countries—What works? *Seminars in Perinatology*. 2010;**34**(6):395-407
- [73] Kamath-Rayne BD et al. Resuscitation and obstetrical care to reduce intrapartum-related neonatal deaths: A MANDATE study. *Maternal and Child Health Journal*. 2015;**19**(8):1853-1863
- [74] Lee AC et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and Delphi estimation of mortality effect. *BMC Public Health*. 2011;**11**(Suppl 3):S12
- [75] Halamek LP. The genesis, adaptation, and evolution of the Neonatal Resuscitation Program. *NeoReviews*. 2008;**9**:142-149
- [76] Niermeyer S. From the Neonatal Resuscitation Program to Helping Babies Breathe: Global impact of educational programs in neonatal resuscitation. *Seminars in Fetal & Neonatal Medicine*. 2015;**20**(5):300-308
- [77] Deorari AK et al. The national movement of neonatal resuscitation in India. *Journal of Tropical Pediatrics*. 2000;**46**(5):315-317
- [78] Gill CJ et al. Effect of training traditional birth attendants on neonatal mortality (Lufwanyama Neonatal Survival Project): Randomised controlled study. *BMJ*. 2011;**342**:d346
- [79] Xu T et al. The impact of an intervention package promoting effective neonatal resuscitation training in rural China. *Resuscitation*. 2014;**85**(2):253-259
- [80] Carlo WA et al. Educational impact of the Neonatal Resuscitation Program in low-risk delivery centers in a developing country. *The Journal of Pediatrics*. 2009;**154**(4):504.e5-508.e5
- [81] Little G, Keenan W, Singhal N, Niermeyer S. Helping Babies Breathe: Evolution of a global Neonatal Resuscitation Program for resource-limited areas. *NeoReviews*. 2015;**15**:369-380
- [82] Newton O, English M. Newborn resuscitation: Defining best practice for low-income settings. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2006;**100**(10):899-908
- [83] Bookman L et al. Educational impact of a hospital-based Neonatal Resuscitation Program in Ghana. *Resuscitation*. 2010;**81**(9):1180-1182
- [84] Trevisanuto D et al. Effect of a neonatal resuscitation course on healthcare providers' performances assessed by video recording in a low-resource setting. *PLoS One*. 2015;**10**(12):e0144443
- [85] Carlo WA et al. Newborn-care training and perinatal mortality in

- developing countries. *The New England Journal of Medicine*. 2010;**362**(7):614-623. Available from: <https://www.nejm.org>
- [86] World Health Organization, Guidelines on Basic Newborn Resuscitation. 2012
- [87] Goudar SS et al. Stillbirth and newborn mortality in India after Helping Babies Breathe training. *Pediatrics*. 2013;**131**(2):e344-e352
- [88] Arabi AM et al. Skills retention in Sudanese village midwives 1 year following Helping Babies Breathe training. *Archives of Disease in Childhood*. 2016;**101**(5):439-442
- [89] Hoban R et al. 'Helping Babies Breathe' training in sub-Saharan Africa: Educational impact and learner impressions. *Journal of Tropical Pediatrics*. 2013;**59**(3):180-186
- [90] Musafili A et al. Evaluating Helping Babies Breathe: Training for healthcare workers at hospitals in Rwanda. *Acta Paediatrica*. 2013;**102**(1):e34-e38
- [91] Seto TL et al. Educational outcomes of Helping Babies Breathe training at a community hospital in Honduras. *Perspectives on Medical Education*. 2015;**4**(5):225-232
- [92] Berkelhamer SK, Kamath-Rayne BD, Niermeyer S. Neonatal resuscitation in low-resource settings. *Clinics in Perinatology*. 2016;**43**(3):573-591
- [93] Kc A, Wrammert J, Clark RB, Ewald U, Vitrakoti R, Chaudhary P, et al. Reducing perinatal mortality in Nepal using Helping Babies Breathe. *Pediatrics*. 2016;**137**(6):e20150117
- [94] Msemu G et al. Newborn mortality and fresh stillbirth rates in Tanzania after Helping Babies Breathe training. *Pediatrics*. 2013;**131**(2):e353-e360
- [95] Bellad RM et al. A pre-post study of a multi-country scale up of resuscitation training of facility birth attendants: Does Helping Babies Breathe training save lives? *BMC Pregnancy and Childbirth*. 2016;**16**(1):222
- [96] Pammi M et al. Newborn resuscitation training programmes reduce early neonatal mortality. *Neonatology*. 2016;**110**(3):210-224
- [97] Sobel HL et al. Immediate newborn care practices delay thermoregulation and breastfeeding initiation. *Acta Paediatrica*. 2011;**100**(8):1127-1133
- [98] Moore L. Measuring quality and effectiveness of prehospital EMS. *Prehospital Emergency Care*. 1999;**3**(4):325-331
- [99] Sasser S, Varghese M, Kellerman A, Lormand JD. Prehospital Trauma Care Systems. World Health Organization; 2005. Available from: https://www.who.int/violence_injury_prevention/media/news/04_07_2005/en/
- [100] Shah MN. The formation of the emergency medical services system. *American Journal of Public Health*. 2006;**96**(3):414-423
- [101] Dick WF. Anglo-American vs. Franco-German emergency medical services system. *Prehospital and Disaster Medicine*. 2003;**18**(1):29-35; discussion 35-37
- [102] Pozner CN et al. International EMS systems: The United States: Past, present, and future. *Resuscitation*. 2004;**60**(3):239-244
- [103] Arnold JL. International emergency medicine and the recent development of emergency medicine worldwide. *Annals of Emergency Medicine*. 1999;**33**(1):97-103
- [104] Roudsari BS et al. International comparison of prehospital trauma care systems. *Injury*. 2007;**38**(9):993-1000

[105] Hay HI. EMS in New Zealand. Emergency Medical Services. 2000;29(7):95-97, 109

[106] Dib JE et al. Analysis and applicability of the Dutch EMS system into countries developing EMS systems. The Journal of Emergency Medicine. 2006;30(1):111-115

[107] Riediger G, Fleischmann-Sperber T. Efficiency and cost-effectiveness of advanced EMS in West Germany. The American Journal of Emergency Medicine. 1990;8(1):76-80

[108] VanRooyen MJ, Thomas TL, Clem KJ. International emergency medical services: Assessment of developing prehospital systems abroad. The Journal of Emergency Medicine. 1999;17(4):691-696

[109] Marinissen MJ et al. Strengthening global health security by developing capacities to deploy medical countermeasures internationally. Biosecurity and Bioterrorism. 2014;12(5):284-291

Ransomware and Academic International Medicine

Andrew C. Miller, Abbas M. Khan and Sophia Ziad

Abstract

Healthcare is among the leading industries targeted by cyber-criminals. Ransomware exploits vulnerabilities to hijack target information technology (IT) infrastructures for monetary gain. Due to the nature and value of information, access to medical information enables cyber-criminals to commit identity theft, medical fraud, and extortion, and illegally obtain controlled substances. The utility and versatility of medical information, extensive centralized storage of medical information, relatively weak IT security systems, and the expanding use of healthcare IT infrastructure all contribute to an increase in cyber-attacks on healthcare entities. Research suggests that an individual's medical information is 20–50 times more valuable to cyber-criminals than personal financial information. As such, cyber-attacks targeting medical information are increasing 22% per year. This chapter explores the history of ransomware attacks in healthcare, ransomware types, ransom payment, healthcare vulnerabilities, implications for international health security, and means of institutional protection.

Keywords: information technology, cyber-attack, ransomware, healthcare

1. Introduction

Healthcare is among the leading industries targeted by cyber-criminals [1]. Malware, or malicious software, refers to programs designed to infiltrate computers without the users' consent, and includes threats such as viruses and ransomware. Ransomware, a version of malware, exploits vulnerabilities to hijack target information technology (IT) infrastructures for monetary gain. Health information is an attractive target for cyber-criminals, as research suggests that an individual's medical information is 20–50 times more valuable than personal financial information [1]. Access to medical information enables cyber-criminals to commit identity theft, medical fraud, and extortion, and illegally obtain controlled substances. The utility, versatility, and centralized storage of medical information, relatively weak IT security systems, and expanding use of healthcare IT (HIT) infrastructure all contribute to an increase in cyber-attacks on healthcare entities [1]. In fact, cyber-attacks targeting medical information are increasing $\geq 22\%$ annually [1]. Depending on completeness, recency, and accuracy, a single patient's file may fetch hundreds to thousands of dollars on the Dark Web [2, 3]. In Australia, it has been reported that the medical card number of every citizen is for sale on the Dark Web [3]. Moreover, attack-associated costs are reported to cost \$1–3.7 million USD to clean up, with an average downtime cost per attack being \$141,000 USD [1, 4–6]. A study by IBM and the Ponemon Institute reported that

cyber breaches in the United States (U.S.) cost up to \$6.2 billion per year and that almost 90% of hospitals have reported a data breach [7].

2. Search strategy

A literature search was performed of: China National Knowledge Infrastructure (CHKD-CNKI), Cochrane CENTRAL, CINAHL, Directory of Open Access Journals (DOAJ), Embase, Korean Journal Database (KCI), Latin American and Caribbean Health Sciences Literature (LILACS), IEEE-Xplorer, information/Chinese Scientific Journals database (CSJD-VIP), Google Scholar, Magiran, PsycInfo, PubMed, Scopus, Scientific Electronic Library Online (SciELO), Scientific Information Database (SID), TÜBİTAK ULAKBİM, Research Gate, Russian Science Citation Index (RSCI), and Web of Science (WoS). Relevant bibliographies were also searched. The search terms included the U.S. National Library of Medicine MeSH terms *hospitals* and *computer security*, as well as the terms *ransomware*, *cyber security*, *web security*, and *healthcare*.

3. What is ransomware?

Ransomware utilizes malicious software to infiltrate computer systems or connected devices to encrypt a user's files in order to carry out an extortion attack [8, 9]. Most commonly, ransomware infects a system when its user opens a compromised e-mail or visits a compromised website (i.e., drive-by downloads) [8]. Once downloaded, servers (i.e., web and e-mail), databases, end-user computers and removable media may become involved, including personal cloud storage services [2, 9]. The intended purpose of encryption is privacy, where someone with access to the encrypted data ("ciphertext") is unable to discern its contents in a readable form ("plaintext") [9]. There are two types of encryption, or cryptography: symmetric key and public key. In symmetric key cryptography, the sender and receiver use the same secret key to encrypt and decrypt the data. Public key cryptography uses a pair of keys: a public key (shared between both parties) and a private key (sender and receiver have their own unique private key) [9].

Ransomware uses a hybrid encryption system that combines the two cryptographies to create an asymmetrical cryptosystem in which data are encrypted using a randomly generated symmetric key, which is subsequently encrypted using a public key where one party has the corresponding private key [9]. The cyber-criminal uses the private key to decrypt the symmetric key in order to decrypt the data back into "plaintext" and sends the key back to the victim, who can then use it to regain access to their system [9].

Once encrypted, information becomes indecipherable and inaccessible. The user receives a pop-up notification demanding payment of a ransom (usually in untraceable digital currency such as bitcoin) in exchange for the decryption key [10]. Ransomware often does not destroy data, but rather, locks-up the data until a ransom is paid [11]. Even if the ransomware infection is removed, the data may remain encrypted [11]. But it is important to note, the mere infection of a machine with ransomware is not enough. The ransomware must communicate with a server to get an encryption key and report its results [11]. This requires a server hosted by a company that will ignore the illegal activity and guarantee the attackers anonymity (called Bulletproof Hosting) [11]. These companies are often located in China or Russia [11]. Attackers also use a proxy or virtual private network (VPN) services to further disguise their own internet protocol (IP) addresses [11]. Attack numbers

have grown in part because malware authors have adopted an easy-to-use modular design of ransomware distribution [12]. This Ransomware-as-a-Service (RaaS) approach has become increasingly available, assisting technically naive attackers through simplistic distribution with phishing and exploitation kits, while employing a trustworthy business model [12]. RaaS is most easily accessed on the Dark Web [13], where prospective cyber-criminals are provided access to an affiliate console allowing them to walk-through the process of receiving their ransomware exploit kit, configure settings, target selection, and selecting ransom rates [13]. Metrics on malware installations and success rates are also available [13].

3.1 Ransomware types

Ransomware can be divided into three basic types: crypto-, locker-, and wipe-ransomware (**Table 1**). Although crypto- and locker-ransomware represent the two main categories, current variants often incorporate traits from both [8]. Crypto-ransomware (most common) encrypts both files and data [11]. Thus, infected files remain inaccessible if transferred to another device [11]. Critical system files are typically spared, enabling the device to continue functioning, as it may be needed to pay the ransom [11]. Additionally, crypto-ransomware prefers bitcoin due to the increased privacy of cryptocurrency. However, owing to worries over law enforcement, bitcoin anonymizers and laundering services have emerged.

Conversely, locker-ransomware (a less effective extortion tool) locks the device by creating a digital “locker” around the computer system to block access [8, 11]. However, unlike crypto-ransomware, the data stored on the device are typically untouched and can often be recovered by moving it to another functioning computer for access [11]. Moreover, users may be able to remove the locker-ransomware remotely and avoid paying the ransom [8]. However, if remote malware removal is unsuccessful, ransom payments are typically made through payment voucher systems or cryptocurrency [8]. For example, online betting services may accept the

Ransomware Type	Examples	Characteristics	Data recoverable by moving files to another device?
Crypto-	Cryptolocker Cryptowall CTB-Locker KeRanger ^a Locky Petya Santana TeslaCrypt TorrentLocker WannaCry	Encrypts files and data. Typically, does not target critical system files, thereby allowing the device to function as it may be needed to pay the ransom	No
Locker-	Reveton	Creates a digital locker around the computer system to block user's access. The data on the device are typically untouched	Possibly
Wipe-	PetrWrap	Encrypts files and data. Does not unlock files or device after ransom payment	No

^aBelieved to be the first piece of ransomware to successfully infect Mac computers (running OS X).

Table 1.
 Ransomware types and characteristics.

voucher codes as payment, subsequently transferring the money to prepaid debit cards [11]. Money mules are then used to withdraw the cash.

Wipe-ransomware first appeared in 2017 with the PetrWrap attack that encrypted the target's master file table (MFT) forcing the operating system (OS) to reboot [14]. Unlike crypto- and locker-ransomware, the files encrypted by wipe-ransomware do not unlock it after payment, effectively resulting in data loss [14].

3.2 Ransom payment

Before 2005, online payment methods were less readily available. Victims were instructed to pay ransoms by sending checks to offshore accounts, SMS text messages, prepaid cards, or even premium rate telephone numbers that earned money for the attacker [11, 15]. However, these methods were risky since they were traceable. In 2008, the largely anonymous cryptocurrency bitcoin came into use, facilitating expansion of ransomware attacks [11]. The use of third-party holdings companies such as PayPal has provided additional payment avenues [15].

Since one's ability to pay may vary greatly by geography and local economy, ransomware uses dynamic geographical pricing. Once a computer or system is infected, the ransomware establishes contact with its command-and-control (C&C) server, reports the infected device's IP address, and the C&C server returns a price for the country associated with that IP address based on a pre-populated database [11]. Additionally, criminals more frequently target businesses than individual users owing to greater potential for ransom extraction. It has been reported that about \$10,000 USD may be the optimal business ransom as it is both low enough to pay, and low enough to generate reluctance on the part of law enforcement to investigate [11].

The decision whether to pay the ransom is critical. The U.S. Federal Bureau of Investigation (FBI) does not recommend paying ransoms, as only 50% of victims ultimately regain access to uncorrupted usable data. Further, ransom payment incentivizes attackers to continue exploiting healthcare targets [16]. Even so, an estimated 40% of organizations choose to pay the ransom in hopes of recovering data accessibility and mitigating further losses [17]. This may be more likely to occur if the hospital has a questionable backup and no business continuity [13].

Choosing not to pay, however, comes with the added costs of extended downtime and recovery, which may approach 23 times the ransom cost [6, 18]. Smaller organizations have been forced to close after not paying the ransom [19]. The FBI estimated that in 2016 alone, ransomware-associated monetary losses exceeded \$1 billion USD, with an average downtime cost per attack of \$141,000 [4–6]. Ultimately, the decision of whether to pay the ransom is an individual one and depends on the unique circumstances and stakes of every incident.

4. Ransomware and healthcare

The targeting of healthcare by ransomware dates to 1989, when the Harvard-trained evolutionary biologist Dr. Joseph L. Popp used malware to prey on scientists and organizations interested in early acquired immunodeficiency syndrome (AIDS) research [1, 11]. Dr. Joseph Popp, a World Health Organization (WHO) consultant and AIDS researcher himself, mailed 20,000 floppy disks containing ransomware to a group of attendees at the WHO's International AIDS conference [1, 11]. When inserted into the target's computer, the virus (known as *AIDS Program*, *AIDS Trojan*, or *PC Cyborg*) infected the computer with a virus that lay dormant until the 90th time the system was re-booted, at which point a note would appear on the

screen asking for licensing fees to be paid while it encrypted and locked computer files [8, 12]. A \$189 USD ransom to be mailed to a physical mailing address was demanded to “renew the software,” or users must forgo further use of their computer [1, 8]. Although authorities apprehended Dr. Popp, his creation resulted in many derivatives that serve as a framework for modern cyber-criminals [1].

Over 15 years passed before the next instance of ransomware (GPCoder), which was delivered via e-mail [15]. Among the first major medical centers attacked was Hollywood Presbyterian Medical Center (2016), a 400-bed hospital in Los Angeles, California [1, 10, 11]. Rather than pay the initial \$3.7 million USD ransom, the hospital reverted to paper records until they were able to negotiate the decryption key ransom payment down to 40 bitcoins (about \$17,000 USD) [1, 10, 11]. However, this does not account for 10 days of lost revenue while the hospital’s systems were inaccessible, nor does it account for a damaged reputation in patient data security. Subsequent U.S. attacks have included academic, government, and private healthcare systems including: Alaska Department of Health Office of Children’s Services (Anchorage, Alaska); Appalachian Regional Hospitals (Lexington, Kentucky); Berkshire Health Systems (Pittsfield, Massachusetts); Emory Healthcare (Atlanta, Georgia); Hancock Regional Hospital (Greenfield, Indiana); Heritage Valley Health System (Pennsylvania); Medstar (Baltimore, Maryland); Kansas Heart Hospital (Wichita, Kansas); Keck Medicine of the University of Southern California (Los Angeles, California); Los Angeles Health Department (Los Angeles, California); Methodist Hospital (Henderson, Kentucky); National Capital Poison Center (Washington, D.C.); Princeton Community Hospital (Princeton, West Virginia); J.W. Ruby Memorial Hospital of West Virginia University (Morgantown, West Virginia); University of Buffalo and State University of New York (Buffalo, New York); and Verity Medical Foundation (San Jose, California) [9, 10, 12, 20, 21]. Additionally, health insurance companies have also been targeted [7]. The Anthem Blue Cross insurance company (USA) had over 78 million medical records stolen in 2015 [7].

This problem, however, is far from constrained to U.S. entities; it is global. On May 12, 2017, a ransomware (WannaCry) that utilized a stolen National Security Agency (NSA) tool that highlighted a vulnerability of the Windows OS (MS17-010) infected more than 300,000 computers in at least 150 countries [12]. Sixty trusts within the United Kingdom’s National Health Service (NHS) experienced system-wide lockouts forcing at least 16 hospital closures, ambulance diversions, inability to access patient records, patient care delays (canceled appointments and elective surgeries), and function loss in connected devices such as MRI scanners and blood storage refrigerators [3, 21–23]. Five hospitals, including Barts Health (Royal London Hospital), one of the main trauma centers in London, had to close their emergency departments [7]. Similarly, the Singapore Health System experienced a breach of over 1 million patient records, including those of the Prime Minister [7].

4.1 Why is healthcare vulnerable?

The rise in healthcare attacks in the U.S. may be linked to the enactment of the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 [24]. This identified healthcare organizations as potential cash cows for cyber-criminals. Prior to 2008, only 9.4% of hospitals had adopted a basic electronic health records (EHR) system [8]. By 2014, 75.5% of hospitals had adopted basic EHRs [8], and now approximately 95% use them [12]. Additionally, HIT including glucose meters, infusion pumps, and implanted medical devices are also connected to, and dependent on, the hospital’s network [12]. Moreover, healthcare systems are twice as likely to have Flash (Adobe Inc., San Jose, USA) installed and three times as likely

to have Java (Sun Microsystems, Santa Clara, USA) installed, two plugins that can be exploited by hackers [8]. Healthcare organizations have been focused on healthcare, not cyber security, thus several issues have increased their vulnerability over time. While aiming to improve care efficiency, increasingly connected technology allowing for multiple ways to connect to easily accessible medical devices increases the likelihood of a breach [3]. Also, the interface between HIT systems and mobile general-purpose consumer devices (e.g., smart phones) increases the challenge to protect PHI. Moreover, no U.S. federal or state law requires encryption for PHI. Though encryption is encouraged, and often incentivized, nothing requires covered entities to utilize even the minimum standard of encryption [8]. Lastly, cyber-security funding is lacking, contributing to time lags between breach occurrence and detection [3].

Importantly, not all ransomware- and malware-generated traffic patterns are distinguishable from the normal traffic patterns generated by medical devices and systems with networking capabilities [21]. In this sense, both a malware encrypting a shared folder and an application compressing the same files have similar traffic patterns. Moreover, normal changes in the clinical environment may be misinterpreted as attacks if detection mechanisms adapt improperly [21]. Furthermore, malware developers are increasingly using encrypted traffic to avoid payload inspection [21]. Thus, achieving an acceptable balance between detection and false alarm rates remains challenging. A high false alarm rate may frustrate administrators and users, whereas a low detection rate may herald inefficacy.

Despite the growth of new technologies, many healthcare organizations persist in using legacy systems. For example, the use of Window XP (not supported since 2014) by some facilities allowed WannaCry to avoid detection [3]. Additionally, the proprietary nature of medical device software may prevent HIT teams from accessing internal device software, resulting in reliance on manufacturers to design and maintain effective device security [3]. Facilities in low- and middle-income countries (LMIC) may be at added risk owing to their use of open-source EMRs whose security may not be rigorously maintained.

Lastly, outsourcing may play a role in healthcare organization vulnerability. Health insurance niche software and service vendors are offering outsourcing as a remedy for organizational cost controls [9]. However, offshore outsourcing companies are mostly self-regulated [9]. There is currently no standard as to how a healthcare provider may ensure that offshore business associates are adequately protecting the electronic PHI of their patients.

4.2 Implications of international health security

With the dominance of ransomware as a leading cyber-security threat, it is important to consider its impact on International Health Security (IHS) [25]. Many countries lack the legal infrastructure to prosecute such crimes. Globally, cyber-attacks may result in substantial loss of resources, money, and life [26]. Although many security threats have emerged from LMIRs, many of these regions lag behind higher income regions in implementation of automated technologies and EMRs in the medical sector. That said, the IHS community is actively endeavoring to increase the availability and use of these technologies in LMIRs [27]. Thus, with falling costs and rising availability and implementation, HIT security will have an increasingly important role in IHS in upcoming years.

Traditional charting and management methodologies are steadily being replaced with digital ones. Technologies including digital algorithms and artificial intelligence are increasingly being used to monitor and coordinate threat responses [28, 29]. The IHS community has come to increasingly rely upon digital global surveillance networks such as the ProMED-mail (PMM) Network and the World Health

Dimension	Role	Recommendation
Leadership		<ul style="list-style-type: none"> • Establish a Board-Level Information Technology (IT) Committee • Hire a Chief Information Security Officer (CIO) • IT security should be under the control of executives with extensive IT experience (e.g., CIO)
Physical safeguards	Prevention and preparation	<ul style="list-style-type: none"> • Buildings and equipment access to protect against unauthorized access and theft
Hardware and software	Prevention and preparation	<ul style="list-style-type: none"> • Encrypt sensitive practice data • Perform regular back-ups. Store 1 copy off-line • Consider tools such as ShieldFS© or Redemption to create real-time safe-guarded copies of attacked files • Maintain a “gold image” of system configurations; this allows one to reset systems to the pre-attack state • Test backup’s restore function regularly (e.g., quarterly or yearly) • Patch management for operating system, application software, browsers, plug-ins, firmware, and anti-virus software • Make sure the firewall is properly configured • Segment the network by categorizing IT assets (e.g., desktops, servers, routers), data, and personnel into groups, and restricting access to these groups using entry and exit traffic filtering
	Incident Response	<ul style="list-style-type: none"> • Disconnect the infected computers from the network • Turn off wireless network functionality of the infected machine • If widespread, shut down all network operations to prevent further spread
Clinical content	Intrusion detection	<ul style="list-style-type: none"> • “Whitelist” or allow only specified programs to run, while blocking all others, to prevent malicious executables from running • Web and e-mail filtering: Block messages with attachments *.exe, *.zip, *.rar, *.7z, *.js, *.wsf, *.docm, *.xslm, *.pptm, *.rtf, *.msi, *.bat, *.com, *.cmd, *.hta, *.scr, *.pif, *.reg, *.vbs, *.cpl, and *.jar from suspicious sources
User interface	Education	<ul style="list-style-type: none"> • Legitimate messages should have a telephone number someone can call (i.e., out of band check), and a personal e-mail address that has a legitimate username that people can check in their local directory; e-mail and website links should display complete internet address (URL) to build trust
	Prevention and preparation	<ul style="list-style-type: none"> • Use a virtual private network (VPN) to create a secure connection, even on a public unsecured network • Establishing strict processes of removable media to prevent ransomware brought into the closed network
	Intrusion detection	<ul style="list-style-type: none"> • At the first sign of an alarm message, turn off the computer and report the incident to the IT support team immediately

Dimension	Role	Recommendation
People	Education	<ul style="list-style-type: none"> • Do not follow unsolicited Web links in e-mails • Train users on ransomware prevention strategies, how to identify malicious e-mails, and to avoid clicking on potentially weaponized attachments
	Identity and access management	<ul style="list-style-type: none"> • Restrict users' administrative privileges on local desktops and laptops. For users who require administrative access, configure two accounts, one with administrative privileges that is used only when necessary, and one with more restrictive privileges that they use for routine activities, including reading e-mail and browsing the Internet • Restrict the ability of users to "write" (i.e., create and delete files), on shared drives of departmental or group shares • Establish policies and processes for protection of HIT systems in smart working environment using cloud computing and teleworking
Workflow and communication	Intrusion detection	<ul style="list-style-type: none"> • Scan all software downloaded from the internet prior to executing
	Risk assessment	<ul style="list-style-type: none"> • Conduct simulated attacks to raise user's awareness • Conduct mock system recovery exercises • Conduct regular risk assessments and auditing
	Identity and access	<ul style="list-style-type: none"> • Dual-factor authentication • More stringent version of the Unique User Identification Standard to prevent generic usernames and passwords
	Incident response	<ul style="list-style-type: none"> • System-wide password reset following a successful attack
Internal policies, procedures and environment		<ul style="list-style-type: none"> • Based on risk and business impact assessments, identify applications and data based on importance to the business (e.g., Tier 0—essential for business operations; Tier 1—1 hour downtime acceptable; Tier 2—1 day downtime acceptable; Tier 3—1 week downtime acceptable) Develop a plan to manage a ransomware situation accordingly • Utilize the principle of "Least Privilege" to limit users' access to only those systems and services required by their job
External rules and regulations	Preparation	<ul style="list-style-type: none"> • Develop a Health Insurance Portability and Accountability Act (HIPPA)-compliant information security regimen
	Incident response	<ul style="list-style-type: none"> • Contact your organization's insurance provider, a computer forensics expert, and the FBI in the event of a successful attack
Measurement and monitoring		<ul style="list-style-type: none"> • Monitor network activity to identify suspicious activity • Monitor the external environment for security incidents and address gaps and deficiencies as they are identified • Review any extended downtime (e.g., ransomware) to identify potential root causes, and discuss future prevention or mitigating procedures

HIT = health information technology.

Table 2.
An approach to preventing or mitigating ransomware attacks.

Organizations (WHO) Global Outbreak Alert & Response Network (GOARN); systems that help organizations improve coordination speed and response time to temper the impact of international infectious disease outbreaks [30–32]. These systems are often used by IHS networks and volunteers in the field and, if compromised, could become a portal of entry for cyber-attack [31]. The attacks on the United Kingdom's NHS demonstrate that even large state-sponsored institutions are not immune to cyber-attack [33].

Laboratory security is another important aspect for IHS, as the use and storage of sensitive pathogens make them attractive targets for attacks [33]. For this reason, the Global Health Security Agenda (GHSA) was created to help increase investment in global health security. GHSA is a 67-nation effort that hopes to increase the availability of laboratory systems for IHS use [34, 35].

5. Protecting your institution

As with most HIT issues, preventing a ransomware attack is a complex socio-technical problem. Richard Schaeffer (2009), the U.S. National Security Agency (NSA) Information Assurance Director, testified to the U.S. Senate Judiciary Subcommittee on Terrorism, Technology and Homeland Security that 80% of all ransomware attacks could be prevented by adhering to security measures already in place [36]. In addition to a sophisticated encryption algorithm, ransomware attacks often rely on some form of “social engineering,” or the psychological manipulation of people to gain their trust and lead them to divulge confidential information [15]. Solving these problems is a shared task between HIT users and those responsible for configuring, maintaining, and operating the HIT infrastructure. While preventing all ransomware attacks is not possible, there are several steps that healthcare organizations can take to reduce risk and mitigate harm (**Table 2**). Additionally, the U.S. Department Health and Human Services (HHS) offer guidelines on the best policies on how to properly secure electronic PHI. The need to maintain software updates and patches cannot be understated. For example, Microsoft Inc. had released a patch for the vulnerability exploited by WannaCry and NotPetya 8 weeks before the attack [8]. If systems had remained up to date, the impact of both malwares would likely have been significantly diminished.

Another approach to recover from a ransomware attack without needing to pay a ransom is by copying a file when it is being modified, storing one copy in a protected area, and allowing any changes to be made to the other [14]. ShieldFS© (NECSTLab, Milan, Italy) approaches this by creating a protected (i.e., read-only) copy of files when a process requests to modify or delete it [14]. If ShieldFS© determines that a process is malicious, the offending process is suspended and the copies can be restored, replacing the modified (encrypted) versions [14]. Conversely, Redemption uses a similar approach, but its technique creates a copy of each of the files targeted by the ransomware and then uses the Windows Kernel Development framework to redirect (or “reflect”) the write requests or filesystem operations (invoked by the ransomware to encrypt the target files) from the target files to the dummy copies in a transparent data buffer, hence leaving the original files intact [14].

Lastly, any ransomware attack should immediately be reported to the appropriate authorities [37]. In the U.S., federal law dictates that any breach undergo a thorough and properly documented analysis to determine if any unsecured PHI was compromised [38–40]. For anything other than a low probability of PHI compromise, one must inform the U.S. Department of HHS as soon as possible, and no later than 60-days post-breach (when over 500 person's PHI is affected) [10, 37, 41].

6. Conclusions

As HIT infrastructure struggles with new technology and security protocols, the industry is a prime target for medical information theft. Even worse, the healthcare industry is lagging behind other leading industries in securing vital data. Healthcare organizations must adapt to the ever-changing cyber-security trends and threats, such as ransomware, where critical infrastructure is exploited, and valuable patient data are extracted. It is imperative that time and funding are invested in maintaining and ensuring the protection of healthcare technology and the confidentiality of patient information from unauthorized access.

Conflict of interest

The authors have no conflict of interests to disclose.

Author details

Andrew C. Miller^{1,2*}, Abbas M. Khan² and Sophia Ziad³


1 Department of Emergency Medicine, East Carolina University Brody School of Medicine, Greenville, NC, USA

2 The MORZAK Collaborative, Columbia, MD, USA

3 Department of Mathematics and Statistics, University of Maryland Baltimore County, Baltimore, MD, USA

*Address all correspondence to: Taqwa1@gmail.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Kruse CS, Frederick B, Jacobson T, Monticone DK. Cybersecurity in healthcare: A systematic review of modern threats and trends. *Technology and Health Care*. 2017;**25**(1):1-10. DOI: 10.3233/THC-161263
- [2] Chernyshev M, Zeadally S, Baig Z. Healthcare data breaches: Implications for digital forensic readiness. *Journal of Medical Systems*. 2018;**43**(1):7. DOI: 10.1007/s10916-018-1123-2
- [3] Coventry L, Branley D. Cybersecurity in healthcare: A narrative review of trends, threats and ways forward. *Maturitas*. 2018;**113**:48-52. DOI: 10.1016/j.maturitas.2018.04.008
- [4] Spence N, Bhardwaj N, Paul DP, Coustasse A. Ransomware in healthcare facilities: A harbinger of the future? *Perspectives in Health Information Management*. 2018;**15**(Summer):1-22
- [5] Cook S. 2017-2019 Ransomware statistics and facts. Comparitech [Internet]. 2019. Available from: <https://www.comparitech.com/antivirus/ransomware-statistics/> [Accessed: 18 November 2017]
- [6] Sussman B. Ransomware: Hackers Are Raising Their Prices. *SecureWorld* [Internet]. 2019. Available from: <https://www.secureworldexpo.com/industry-news/ransomware-hackers-raising-prices> [Accessed: 25 November 2019]
- [7] Ghafur S, Kristensen S, Honeyford K, et al. A retrospective impact analysis of the WannaCry cyberattack on the NHS. *npj Digital Medicine*. 2019;**2**:98. DOI: 10.1038/s41746-019-0161-6
- [8] Slayton TB. Ransomware: The virus attacking the healthcare industry. *The Journal of Legal Medicine*. 2018;**38**:287-311. DOI: 10.1080/01947648.2018.1473186
- [9] Krisby RM. Health care held ransom: Modifications to data breach security and the future of health care privacy protection. *Health Matrix*. 2018;**28**:365-401
- [10] Pope J. Ransomware: Minimizing the risks. *Innovations in Clinical Neuroscience*. 2016;**13**(11-12):37-40
- [11] Richardson R, North MM. Ransomware: Evolution, mitigation and prevention. *International Journal of Management Reviews*. 2017;**13**(1):10-21
- [12] Branch LE, Eller WS, Bias TK, et al. Trends in malware attacks against United States healthcare organizations, 2016-2017. *Global Biosecurity*. 2019;**1**:15. DOI: 10.31646/gbio.7
- [13] Kelpsas B, Nelson A. Ransomware in hospitals: What providers will inevitably face when attacked. *The Journal of Medical Practice Management*. 2016;**32**:67-70
- [14] Hull G, John H, Arief B. Ransomware deployment methods and analysis: Views from a predictive model and human responses. *Crime Science*. 2019;**8**:1-22. DOI: 10.1186/s40163-019-0097-9
- [15] Sittig DF, Singh H. A socio-technical approach to preventing, mitigating, and recovering from Ransomware attacks. *Applied Clinical Informatics*. 2016;**7**(2):624-632. DOI: 10.4338/ACI-2016-04-SOA-0064
- [16] Federal Bureau of Investigation, U.S. Department of Justice. *Cyber Crime* [Internet]. 2019 Available from: <https://www.fbi.gov/investigate/cyber/> [Accessed: 17 November 2019]
- [17] Harley D. Ransomware: To Pay or Not to Pay? *WeLiveSecurity* [Internet]. 2016. Available from: <https://www.welivesecurity.com/2016/08/22/>

ransomware-pay-not-pay-2/ [Accessed: 01 May 2020]

[18] Pelley S. How cybercriminals hold data hostage ... and why the best solution is often paying a ransom. CBS News 60 minutes [Internet]. 2019. Available from: <https://www.cbsnews.com/news/ransomware-how-cybercriminals-hold-data-hostage-why-the-best-solution-is-often-paying-a-ransom-60-minutes-2019-08-25/> [Accessed: 18 November 2019]

[19] Sussman B. Doctors quitting due to ransomware attacks. SecureWorld [Internet]. 2019. Available from: <https://www.secureworldexpo.com/industry-news/are-doctors-quitting-after-ransomware-attacks> [Accessed: 17 November 2019]

[20] Zhao JY, Kessler EG, Yu J, Jalal K, Cooper CA, Brewer JJ, et al. Impact of trauma hospital Ransomware attack on surgical residency training. *The Journal of Surgical Research*. 2018;**232**:389-397. DOI: 10.1016/j.jss.2018.06.072

[21] Fernández Maimó L, Huertas Celdrán A, Perales Gómez ÁL, García Clemente FJ, Weimer J, Lee I. Intelligent and dynamic ransomware spread detection and mitigation in integrated clinical environments. *Sensors*. 2019;**19**(5):E1114. DOI: 10.3390/s19051114

[22] Collier R. NHS ransomware attack spreads worldwide. *Canadian Medical Association Journal*. 2017;**189**(22):E786-E787. DOI: 10.3390/s19051114

[23] Cohen IG, Hoffman S, Adashi EY. Your money or your Patient's life? Ransomware and electronic health records. *Annals of Internal Medicine*. 2017;**167**(8):587-588. DOI: 10.7326/M17-1312

[24] Charles D, Gabriel M, Searcy T. *ONC Data Brief No 23. Adoption of*

electronic health record systems among U.S. non-federal acute care hospitals: 2008-2014. The Office of the National Coordinator for Health Information Technology, U.S. Department of Health and Human Services. 2015. Available from: <https://www.healthit.gov/sites/default/files/data-brief/2014HospitalAdoptionDataBrief.pdf> [Accessed: 02 February 2020]

[25] Park R. *ISTR Insights Special Report: Ransomware and Business 2016*. Symantec Connect [Internet]. 2016. Available from: <https://www.symantec.com/connect/blogs/istr-insights-special-report-ransomware-and-business-2016> [Accessed: 01 May 2020]

[26] Bambery Z, Cassell CH, Bunnell RE, Roy K, Ahmed Z, Payne RL, et al. Impact of a hypothetical infectious disease outbreak on US exports and export-based jobs. *Health Security*. 2018;**16**(1):1-7. DOI: 10.1089/hs.2017.0052

[27] Thompson R, Perache AH. *Optimism Meets Realism: The Politics of Technology Innovation in Global Health Security*. Chatham House: The Royal Institute of International Affairs [Internet]. 2018. Available from: <https://medium.com/chatham-house/optimism-meets-realism-the-politics-of-technology-innovation-in-global-health-security-54c82ad4aa89> [Accessed: 01 May 2020]

[28] Eckmanns T, Füller H, Roberts SL. *Digital epidemiology and global health security; an interdisciplinary conversation*. *Life Sciences, Society and Policy*. 2019;**15**(1):2. DOI: 10.1186/s40504-019-0091-8

[29] Simao MBG, Heymann DL, Sampath R, Kunii O, Koshiba M, Jones C, Hughes S. *Harnessing New Technologies for Global Health Security*. Chatham House: The Royal Institute of International Affairs [Internet]. 2018.

Available from: <https://chathamhouse.soutron.net/Portal/Default/en-GB/RecordView/Index/181928> [Accessed: 01 May 2020]

[30] Institute of Medicine (US) Forum on Microbial Threats. *Global Infectious Disease Surveillance and Detection: Assessing the Challenges*. Washington D.C.: National Academies Press; 2007

[31] Mackenzie JS, Drury P, Arthur RR, Ryan MJ, Grein T, Slattery R, et al. The global outbreak alert and response network. *Global Public Health*. 2014;**9**(9):1023-1039. DOI: 10.1080/17441692.2014.951870

[32] Roberts SL, Elbe S. Catching the flu: Syndromic surveillance, algorithmic governmentality and global health security. *Security Dialogue*. 2017;**48**(1):46-62. DOI: 10.1177/0967010616666443

[33] Macintyre CR, Engells TE, Scotch M, Heslop DJ, Gumel AB, et al. Converging and emerging threats to health security. *Environment Systems and Decisions*. 2018;**38**:198-207. DOI: 10.1007/s10669-017-9667-0

[34] Osterholm MT. Global Health security—An unfinished journey. *Emerging Infectious Diseases*. 2017;**23**(13):S225-S227. DOI: 10.3201/eid2313.171528

[35] Global Health Security Agenda [Internet]. 2019. Available from: <https://ghsagenda.org/> [Accessed: 01 May 2020]

[36] Zetter K. Senate panel: 80 percent of cyber attacks preventable. *WIRED* [Internet] 2009. Available from: <https://www.wired.com/2009/11/cyber-attacks-preventable/> [Accessed: 02 February 2020]

[37] Office for Civil Rights. My entity just experienced a cyber-attack! What

do we do now? U.S. Department of Health and Human Services [Internet]. 2017. Available at: <https://www.hhs.gov/sites/default/files/cyber-attack-checklist-06-2017.pdf> [Accessed: 01 May 2020]

[38] Healthcare for Ransom: A Look into the HIPAA Guidelines for Ransomware Incidents. Trend Micro™ [Internet]. 2016. Available at: <https://www.trendmicro.com/vinfo/pl/security/news/cybercrime-and-digital-threats/healthcare-for-ransom-a-look-into-the-hipaa-guidelines-for-ransomware-incident> [Accessed: 01 May 2020]

[39] Snell E. Breach notification center of presence health HIPAA settlement. *Health IT Secur* [Internet]. 2017. Available from: <https://healthitsecurity.com/news/breach-notification-center-of-presence-health-hipaa-settlement> [Accessed: 18 November 2019]

[40] United States Government Interagency Guidance Document, FACT SHEET: Ransomware and HIPAA. U.S. Department of Health and Human Services [Internet]. 2016. Available from: <https://www.hhs.gov/sites/default/files/RansomwareFactSheet.pdf> [Accessed: 01 May 2020]

[41] Office of Civil Rights. Submitting notice of a breach to the secretary. U.S. Department of Health and Human Services [Internet]. 2015. Available from: <https://www.hhs.gov/hipaa/for-professionals/breach-notification/breach-reporting/index.html> [Accessed: 18 November 2019]

The Evolving Interplay between Social Media and International Health Security: A Point of View

*Keith Conti, Shanaya Desai, Stanislaw P. Stawicki
and Thomas J. Papadimos*

Abstract

Human communication and interaction had been rapidly evolving with the advent and continuing influence of social media (SM) thereby accelerating information exchange and increasing global connectivity. Despite clear advantages, this new technology can present unintended consequences including medical misinformation and “fake news.” Although International Health Security (IHS) stands to benefit tremendously from various SM platforms, high-level decision-makers and other stakeholders must also be aware of the dangers related to its intentional and unintentional misuse (and abuse). An overview of SM utility in fighting disease, disseminating life-saving information, and organizing people and teams in a constructive fashion is discussed herein. The potential negatives associated with SM misuse, including intentional and unintentional misinformation, as well as the ability to organize people in a disruptive fashion, will also be presented. Our treatise will additionally outline how deliberate misinformation may lead to harmful behaviors, public health panics, and orchestrated patterns of distrust. In terms of both its affirmative and destructive considerations, SM can be viewed as an asymmetric influencing force, with observed effects (whether beneficial or harmful) being disproportionately greater than the cost of the intervention.

Keywords: global health security, International Health Security, social media, misinformation, fake news

1. Introduction

International Health Security (IHS) includes a broad range of intertwined subject areas related to human security [1–4]. Introduced by the United Nations in the mid-1990s, the definition of “health security” is nebulous because of an overlap between its constituent “health” and “security” components [5]. Thus, there continues to be debate about the degree of such overlap and its implications. In addition, although traditional IHS applications focus on bio-terrorism and emerging infectious diseases (EIDs) [6, 7], the concepts of “health” and “security” can be applied more broadly when different man-made and non-man-made factors, from climate change to cyber health security are considered [8–11].

The domination of personal and professional human interactions by the increasingly more powerful and sophisticated social media (SM) platforms brought with

it many benefits and challenges. For example, SM has introduced conditions for cyberbullying, voter/public opinion manipulation, and criminal activity despite its well-intended attempts to bring people together in the digital, boundaryless environment [12]. Here, we will discuss how SM can create both constructive and destructive forces, focusing specifically on IHS and related topic areas.

2. The definition of social media

SM's definition and sphere of influence extend to "any medium involving user-generated content" [13, 14]. Assorted subdomains within SM may include blogs or microblogs, interactive forums, message boards, social networks, wikis, as well as other types of audiovisual media-based platforms (e.g., photo or video sharing sites) [13–15]. Comprehensive acceptance of SM contributed to a startling rise in the overall amount of information being shared, the acceleration and pervasiveness of such sharing, as well as the ability to interact across nearly all areas of human activity, inclusive of public health and medical care [12, 16]. It must be noted that the vast volume of shared information on SM is largely unfiltered and difficult to verify.

The reach and breadth of SM platforms and related communication tools have developed exponentially and matured as the Internet has expanded [14, 17, 18]. During this time, the purpose and focus of various SM tools remained poorly defined [19, 20]. While altruism is at the heart of most large SM platforms, it is difficult to promote (or enforce) its charitable and humanitarian application by end-users, especially in the context of best interest of communities [21–23]. As with all discourses involving the interchange of knowledge, transparency becomes a paramount concern in that any information disclosures are made in a manner that is both open and honest, in effect strengthening the legitimacy of the involved SM platform [24–26]. It is critical that SM adheres to accepted ethical and scientific norms and that this adherence applies to the full range of related domains, including bioinformatics, statistical testing, peer-review, and independent validation [27–34]. It should be emphasized that particularly when it pertains to SM in the context of the subsequent IHS arguments made in this chapter, the most popular, seemingly persuasive, and commonly repeated messaging does not always constitute the absolute truth or reliable information, and that one should be free to question and challenge any data he/she is presented with [35–40]. This is especially applicable in the setting of question-and-answer format of information exchange, where both relevance and quality of information are critical [40].

3. Social media platforms: "weaponizing" human emotions and interactions

The very presence of today's Internet has created the expectation of internationalization and universal information sharing amid the rapidly evolving frameworks of technological and social change [41–43]. As the Internet matured, the type and presentation of the information itself evolved, with increasing participation of highly diversified, user-furnished content [44]. Human beings have always valued the stimuli provided by their senses, either consciously or subconsciously. People tend to create various reference points, both to self and others, allowing the construction of an environment that psychologically conditions its participants. This may lead to a compulsive feedback loop that emerges from intense competitive pressures, with users trying to out-compete themselves and others in search of external affirmation [45–49]. As part of its continued development, the Internet became rich in various

audio-visual representations specifically designed to show appreciation or depreciation of the stimuli [49–51]. From a historical perspective, the first “like” button has been attributed to Vimeo, a video sharing platform that appeared in 2005 [52, 53]. Vimeo designers were inspired by Digg, a Website that encouraged the clicking of a button labeled “digg” when a rewarding picture was observed by an end-user or an interesting article was read. Similar concepts have been fully embraced across the SM sphere and serve as the “fuel” in the highly gamified “ratings” competition [53–56].

The concept of “liking” or providing “virtual endorsement” to an information snippet on an SM platform has sparked intense research into the implications and consequences of such an action that, on initial blush, appears benign [57–59]. More specifically, there is evidence that an action of providing a “like” creates a basis for a “directed voting” or reward system of sorts [59, 60]. Early research by Davey et al. [61] investigated the effect of “being liked” on specific regions of the brain. Primary reward and self-related regions were activated under such conditions (e.g., nucleus accumbens, ventral tegmentum midbrain, ventromedial prefrontal cortex, and amygdala among others) [61]. Furthermore, there was a proportionately greater activation of these neurological regions in response to “being liked” by individuals who are more highly regarded [61]. Sherman et al. [62] used a computer program resembling Instagram (Facebook, Inc., Menlo Park, California, USA) to investigate regions of the brain that exhibited significant activity when an image was “liked.” Their results showed statistically significant activation in the dorsal and ventral striatum, ventromedial prefrontal cortex, midbrain, and amygdala when “liking” an image versus simply pressing “next” to view the subsequent image [62]. The former regions were implicated in reward and the latter being implicated in reward processing [63, 64]. Sherman et al. [62] did note that the esthetic quality of the image itself can lead to activation of similar pathways. If both the “act of liking” and the act of “receiving a like” are being interpreted as rewards, it becomes clear as to why SM has been expanding so quickly. However, this also leads to the question, what are the consequences of such rewards?

Studies have linked these changes to dopaminergic system and its corresponding communication with the striatum [65]. When looking at the effects of “like” from the neuroscience perspective, functional MRI studies of SM users suggest that the “popularity of a photo” has a significant effect on its viewer’s perception. A popular photo was more likely to receive more “likes” from SM peers regardless of the activity being portrayed [66]. Sherman et al. [65] went on to discuss the quantification of social endorsement as an important example of sociocultural learning. Moreover, the question arises as to whether individuals actively engaged in SM-based discourses are more likely to neglect direct human interactions in favor of reaching larger, “virtual and impersonal” audiences [46, 67, 68]. If so, what are the implications of such conditioning to the ability to critically evaluate information encountered on SM platforms? Likewise, how does one sort out what is real versus what is virtual, as well as the impact of information upon each of these domains?

Before venturing back to the primary discussion of the relationship between SM and IHS, the concepts of “vague-booking” and “mediated lurking” should be noted [66, 69]. Berryman et al. [66] define “vague-booking” as sharing “ambiguous but alarming posts” to attract attention. “Mediated lurking” on the other hand is defined as becoming a member/user of a SM platform but “wishing to go largely undetected” [69, 70]. Finally, one would be remiss without mentioning the potential for “cyberbullying” and “cyber aggression” [71, 72]. These phenomena can create a real and damaging link between online and real-life behaviors [71, 73, 74]. Aggressive online behaviors have been categorized into subtypes, which include hostile aggression (e.g., “an act of aggression stemming from a feeling of anger and aimed at inflicting pain or injury”) and instrumental aggression (e.g., “an intention

to hurt the other person, but the hurting takes place as a means to some goal other than causing pain”) [75]. Within this general context, SM facilitates and escalates negative behaviors that may serve to “deliver aggression,” while not being physically present, yet directed toward the person of interest. Jamison et al. [76] investigated the types of malicious actors that are found on Twitter (Twitter, San Francisco, California, USA) and the potential ramifications of their influence. Three categories of malicious actors were identified: (1) automated accounts (i.e., bots without human influence once created), (2) semiautomated accounts (i.e., bots with some degree of human influence), and (3) malicious humans [76]. Malicious SM actors have been labeled “trolls,” with the associated activity of “trolling” defined as “posting denigrating and inflammatory messages in order to argue and/or emotionally upset individuals” [77]. Each form allows for altering influence, as well as delivering aggression. In particular, if the actors can deliver an aggressive message with a disregard for any ramifications, they are in fact executing the purest form of passive aggression, a demonstration of hostile feelings in a non-confrontational manner [78, 79]. All of the above definitions, characteristics, behavioral patterns, and consequences play an important role in the “weaponization” of SM as it relates to IHS. Within this psychological context, a discussion of various aspects of concern regarding targeted SM content manipulation is warranted [80].

4. Social media in public health

As outlined in previous sections, SM has several emerging real-life applications in public health [81]. It is a powerful platform for real-time data collection, especially during fast-moving events such as epidemics or outbreaks [81, 82]. User inputs on SM platforms may help with the detection—and subsequent mapping—of geographic patterns for disease-specific signs or symptoms, confirmed cases, and/or other relevant parameters [83]. The resultant data can then be filtered, tracked, collected, analyzed/modeled, and reported [84, 85].

The use of SM to analyze various aspects of disease outbreaks (e.g., prediction, detection, and tracking) was described in the early 2010s by several independent groups [86–89]. SM was felt to be instrumental in containing the Ebola outbreak in Nigeria through enhanced information sharing and coordination between front line personnel [85]. While Internet “search engines” are valued tools, primarily because they can be used in the leveraging of targeted marketing and sales, their use in characterizing the epidemiology, and geographic evolution of an emerging disease [90–92] as well as other more scientifically focused endeavors [93, 94] is of unquestionable worth. Increased frequency of specifically tracked search queries, such as “how does one prevent the flu,” “what is the treatment of the flu,” and “what are the most common symptoms of the flu” have shown accuracy and temporal correlation with the extent of disease spread and its prevalence, especially when contrasted against more traditional means of tracking outbreak progression. There is also a strong correlation between trends identified by “Internet search engines” and phenomena such as emergency department visits by patients with influenza [95]. A striking example of the correlation between Google™ Trends and an emerging infectious threat was recently demonstrated in an “infodemiological” study of the Wuhan coronavirus (2019-nCoV) [96]. Still, it is not surprising that some pragmatic researchers urge caution when using such information in the absence of complete epidemiological understanding, context, and expert interpretation [97, 98].

Despite some flaws, strict adherence to proper scientific methodology and structured peer review can provide reasonably robust ways of enforcing proper balance to help minimize the risk of propagation of false or misleading information

[99–101]. To ensure wide adoption, SM platforms tend to be open and inviting, thus providing an essentially unrestricted forum for the exchange of ideas. Much of this occurs in the name of “protecting and enabling free speech.” Consequently, short of legal action, objective accountability for communicated content is lacking at best [102–105]. In certain scenarios, unrestricted online attacks can be very destructive, including consequences in both in the “real” and “digital” domains, and both personally and professionally [12, 106]. Some forms of malicious SM participation have been discussed in an aforementioned section. Among established SM platforms, there seems to be a struggle to find a balance between self- or user/community-censorship and various forms of “online aggression” [12, 72, 107]. Significant spillover into public health can occur, especially among minors, and can have tremendous impact when “online actions” translate into “real-world implications” [108–111].

5. International Health Security: constructive uses of social media

It has been shown that SM-based vigilance can be useful for outbreak or epidemic interception, tracking, and data reporting [86, 87, 112, 113]. In the midst of the 2014 Ebola outbreak in West Africa, isolated islands of the disease were successfully contained leveraging SM-based coordination tools, including targeted identification of misinformation and its prompt correction [85]. SM can also be valuable to public health community when determining how human networks behave in the context of social determinants of health (e.g., health behaviors, resource availability, and general compliance) [114]. Thus, SM may be particularly helpful in promoting positive health behaviors [115]. All of the above implementations of SM in public health are now being actively employed during the Wuhan 2019-nCoV outbreak, with focus on augmented intelligence in the context of preventing the spread of the disease [116, 117]. An additional use case for SM, as reported in conjunction with the 2019-nCoV, is the promotion of psychological crisis interventions using popular SM channels to share strategies for dealing with stress and anxiety associated with the outbreak [118].

6. International Health Security: potentially harmful aspects of social media use

The sharing of non-peer-reviewed information over SM entails the potential of transmitting misinformation or misinterpretation of such unfiltered content [119], especially if it is out of context. The hourly volume of SM messaging that may contain “inaccurate or fake news” outnumbers “fact checking” capabilities by as much as 10-fold [120]. In addition, the average time between the release of “fake news” and any “fact checking” response may be greater than 12 hours, thereby causing significant damage before the misinformation can be rectified [120]. Thus, misinformation introduced into public discourse can be substantial if placed by a highly motivated and appropriately equipped individual (or group). In the context of IHS, the consequences can be profound when “fake news” is carefully crafted and communicated in a strategic manner (**Table 1**). “Fake news” can be damaging in several ways, from spreading false claims (e.g., that risk of vaccines is greater than their benefits), to misinforming the public regarding a particular health condition (e.g., misstating signs and symptoms of a viral infection). Programmatic moderation of content is one of the solutions that SM outlets have embraced, but this process is very resource-intensive, may be quite cumbersome, and may not apply universally across different types of data [121, 122]. Additionally, in regard to

Harmful behavior	Description	Comments
Cyberbullying	SM content that is of intimidating or threatening in character, with potential for risk to self or others. Associated harm may be both mental and physical	Robust surveillance, reporting, and prompt remediation; establishing and enforcing accountability, as applicable
Fabricated or “fake” news	Intentional release of erroneous news and information via both traditional and SM. Consequences can be both unintended and unpredictable, including intentionally or unintentionally harmful or damaging behaviors, or misdirected action	Adherence to established news reporting standards; Sound editorial policies and procedures. Appropriate fact-checking and prompt intervention to avoid any resultant or potential harm
Intentional misinformation	Leading individuals to perform actions that may have harmful consequences on self or others. Release of intentional misinformation may result in random and unpredictable downstream events. The process involves the end-user receiving, processing, and implementing any information before actual harm can result	Empowering SM moderators to remove harmful content; Vigilance, fact-checking, and timely intervention to prevent any potential or actual damage from dissemination of false information; legal consequences for intentional introduction of potentially damaging misinformation
Misinterpretation	Erroneous conclusions made regarding data generated or compiled from SM inputs. Although usually not intentional, this may lead to misguided planning or implementations, with some potential for harm	Careful cross-checking and verification of both the source data and the analytical methods; use of established decision-making algorithms and verification mechanisms

SM, social media.

Table 1. *Primary modes of deleterious behavioral patterns described on social media, with associated characteristics, potential for negative consequences, and proposed remedial/corrective measures.*

SM and addiction, there are significant correlations between symptoms of addiction to technology use and mental health conditions [123]. Furthermore, more advanced technological applications, such as virtual reality, have been associated with dissociation and lower “sense of presence” in objective reality [124]. Various psychological aspects and nuances associated with SM use were discussed earlier in the chapter, and the reader is referred there to avoid content redundancy.

Although SM can provide an excellent medium for open discourse on a broad range of topics, the troubling reality is that SM may foster a society with fewer defined boundaries (e.g., “real-life friend” versus “social media friend”) [125, 126]. Thereby no longer plainly demarcating a defined personal space and presenting a risk of intentional or unintended “invasion” [127, 128]. Although SM’s negative aspects have been addressed, there is little doubt that responsible use of SM facilitates the public awareness of various health/mental health matters and thus can provide an overall positive influence.

There are examples of SM as a successful tracking tool of actual disease outbreaks/epidemics [86]. However, the risk of “false alarms” does exist, potentially affecting the utility of SM as a useful public health tracking tool at the population level [129]. The tracked data often lack specificity [130], can be misinterpreted and/or distorted, and subsequently promoted by influential personas without appropriate training or content expertise [131, 132]. Reversing damage caused by distortion of the facts and misinterpretation can be challenging [133–137]. For example, the controversy regarding the alleged association between childhood vaccination and autism exemplifies how concerns of global nature can be distorted in a highly publicized fashion [138–140]. Despite multiple research studies that were

unable to definitively prove a connection between childhood vaccines and autism, large groups within the society still advocate otherwise [141–143]. Unfortunately, misplaced trust tends to be given to the messengers and various SM tools, rather than the authorities and the medical community [144–146]. These considerations need to be taken from the perspective of IHS, especially when one realizes that the “most prominent voice” is not universally the one with the correct or the best answer [147, 148].

There is a clear and present danger of malignant actors abusing SM to spread disinformation that may potentially lead to third-party harm [149, 150]. In 2009, in the midst of the swine influenza season, there was a substantial uptick in SM reporting of various conspiracies about the flu virus, its alleged genetically engineered origins, and other unfounded rumors [151–153]. Thousands of user views of the questionable material were recorded by involved SM platforms, which was likely a significant underestimate [151–153], with literally thousands of other search results on the “swine flu epidemic” topic [154]. Similar sources of misinformation continue to be abundant despite their unfounded assumptions and obvious danger [155, 156]. For example, SM outlets are rich with unfounded speculation regarding the most recent coronavirus outbreak in Wuhan, China [157, 158]. Vijaykumar et al. [159] describe the so-called “social media virality risk,” which attempts to quantify the amplification of the population’s perception of public health risk in the overall context of “social media effectiveness.” Their conceptual model is called Risk Amplification through Media Spread (RAMS) [159].

Of critical importance, SM platforms may be preferred by individuals (or groups) who perceive the lack of other means to express their beliefs and thoughts. As such, SM can be thought of as “virtual aggregators” for people who share generally compatible and/or synergistic viewpoints [160–162]. Moreover, there is a non-trivial risk of evolution of such “virtual groups” beyond “online presence” [163]. Traditionally, unconventional or controversial beliefs tended to be often marginalized by the society, with relative lack of effective platforms to share thoughts and ideas [164–166]. In current times, essentially every idea can have an “online home” with SM actively facilitating the aggregation of like-minded people into groups [167, 168]. And although “virtual homes” can become hubs for creativity, innovative thinking, scientific discovery, understanding, diversity, and idea exploration, they can also be the sources of damaging misinformation. Finally, there is at least some evidence that SM may also create an avenue for people to explore different points of view, thus potentially providing an avenue for “new perspectives and open mindedness” [159, 169]. **Table 2** shows an overview of characteristics likely to be correlated with misinformation, with a focus on SM-related aspects.

Equipped with SM tools, “malignant actors” can develop a substantial potential for harm and otherwise destructive consequences. Thus, the malignant use of SM poses a risk to IHS. Beyond this, unimpeded access to Internet infrastructure, when “passively” permitted by countries/governments, can create conditions for the “malignant actor” or “fictitious public discourse” to lead to societal disruption and harm, involving both institutions and individuals [170, 171]. The subsequent sections will discuss malignant use cases where SM manipulation is centralized (e.g., government) versus decentralized (individuals, special interests, and non-governmental groups).

When centralized control of Internet infrastructure (e.g., government) is present, a narrative can in theory be created at the top echelons of power, and wide dissemination of messaging can be reasonably easily achieved. Under well-intended circumstances, this capability should be used to facilitate education and positive health behaviors. Having said that, if a central authority is the “bad actor” and their messaging is used to “manipulate” public discussions, the message may constitute an

Factor	Comment
Anonymous authorship	Although some press/news releases may not give credit to specific author(s) or source(s), stories/information from anonymous sources (especially if impossible to independently verify) should prompt additional confirmation; this is especially true when making policies or implementing procedures based on such information
Attractive or “catchy” headline	A “catchy” headline tends to attract a larger number of viewers and may help enhance subsequent dissemination of (mis)information
Cult-like followership	Concepts that attract cult-like (often fanatical) followership tend to be more prone to aggregate “SM communities” around them. This, in turn, may assist in further propagation of biased/false information
Disclaimer regarding the information is provided alongside the content	In most cases, sources that feature a disclaimer should be considered with caution, mainly because disclaimers tend to be used in the setting of potential liability risk
Dramatic or otherwise emotional nature of the content	If the content contains dramatic or emotional language, and/or leads to a strong emotional response, it was most likely intended to do so. Oftentimes, hidden agenda(s) may be present
Forward-looking claims or predictive statements may be embedded	News content that provides specific claim of a future event is most likely unauthentic. Likewise, when faced with reports of an effective therapy, end-users should carefully seek verification and remain skeptical
Information superficially “appears” to be legitimate	When “crafted and disseminated” in a specific and deliberate fashion, wrong information may appear legitimate. Only after a more careful/detailed review, factual or logical inconsistencies may be found
Reputable source/origin of the information is claimed by authors	FN may gain more credibility if the source “appears” legitimate. Having said that, any significant claims from an apparently respected source must be substantiated and verified, especially if the story’s author is not clearly identifiable (see above under “anonymous authorship”)
Propagation by high-profile individuals	Superficial appearance of credibility can often be maintained around fictional story accounts, especially when reputable individuals (e.g., community leaders, politicians, scientists) participate in information dissemination
The story is too good to be true...	In cases where SM information appears to be “too good to be true,” the end-users should remain critical and question any such reports/stories
Unusual or atypical domain name/uniform resource locator (URL)	When content is located on a Website, or originates from a source with an unusual domain name, suspicious user identification, and/or URL, skepticism is always wise

FN, fake news; SM, social media; URL, uniform resource locator.

Table 2.

Factors that may signal that one is exposed to attempts at the dissemination of “fake news” and misinformation on social media platforms.

attempt to influence various policy objectives, such as a particular therapy, vaccine, or preventive health measure (s) [172, 173]. Corrupt central authorities may also manipulate SM messaging for monetary gain and/or political goals [174–176]. In this context, focused SM messages may involve falsified statements, manipulated statistics, and edited images. Such messaging can be directed at a particular target, including religious, ethnic, racial, political, and gender-specific or other groups [177–179].

When central control is not present, but laws and/or executive orders render SM fully unrestricted to all potential actors, then the so-called *peripheral control* can be attained [180–182]. Under such circumstances, individuals or interests can freely target selected individuals, groups, and organizations for manipulation via dissemination of false information via SM [183–186]. In the arena of *peripheral control*, third-party entities (e.g., interest groups) who wish to influence a particular policy

are able to use SM disguised as indigenous individuals or organizations, modulating the discourse to their benefit [187]. Inherent to modern capitalist societies is that major SM platforms are for-profit entities and thus can be maneuvered using financial resources to influence a society from the periphery [130, 188]. Finally, there is a less likely possibility that the more dominant SM platforms may evolve into new “central authorities” over time.

From public health standpoint, the potential for harm is both real and significant. Hypothetically, a broad range of harmful actions may be initiated using misguided SM, including the manipulation of populations to report to wrong/inappropriate locations for assistance [189, 190], misdirecting local populations with regard to the evacuation routes, sanctuaries/safe places, as well as creating public distress that leads to waste or misuse of precious public health resources [191–193]. Of importance, healthcare workers could theoretically be manipulated through SM platforms against accepting the risks associated with care for those in need, thus effectively negating a provider’s professional obligations [194, 195]. Although various conspiracy theories have been propagated throughout the history, their dissemination has escalated in the era of multiple SM platforms [196, 197]. As a result, the risk exists of an “engineered reality” by individuals or entities, using SM as the ultimate “mind bending” tool [198]. The theme of SM contributing to fear and misinformation or disinformation in the IHS context continues into the 2020s, with similar concerns being noted around the SARS-CoV-2 outbreak [199].

Finally, ongoing high-level efforts are underway to reduce the harm from SM-based disinformation at the national and international levels. More specifically, there is an increasing number of governmental and non-governmental organizations that actively focus on this important health security problem. This growing list includes the National Cyber Directorate in Israel, the National Security Communications Team (NSCT) in the United Kingdom, the Australian Security Intelligence Organization (ASIO) and the Department of Home Affairs in Australia, the Security Intelligence Service and the Defense Intelligence Service in Denmark, and the National Security Agency in France, among many others. In addition, major SM providers are signatories to the European Union (EU) Code of Practice on Disinformation. However, the same providers are not bound by this Code of Practice outside of the geographic boundaries of the Union [200].

7. Conclusions

Continuous worldwide information sharing fosters innovation and knowledge creation, thus facilitating humanity’s ongoing progress. The same is true regarding the implementation of SM tools in the area of public health/health security. Although there are undoubtedly important benefits of SM in this realm, the in-depth understanding of modern SM platforms is still somewhat limited. The introduction of SM into the domain of public health presented the community with a unique opportunity for the development of highly efficient, integrated tools for disease tracking and epidemiologic trend identification. At the same time, users must remain cautious because the potential for both intentional and unintentional misuse of data may be present, resulting in substantial and often unpredictable harm. Finally, malignant actors in control of the SM narrative can cause deliberate harm through the intentional propagation of “fake news” and misinformation. Consequently, risks and benefits associated with the use of SM in the realm of public health/IHS must be carefully considered to minimize any negative downstream consequences.

Author details

Keith Conti¹, Shanaya Desai², Stanislaw P. Stawicki^{3*} and Thomas J. Papadimos⁴

1 Medical School of Temple/St. Luke's University Health Network,
Bethlehem, Pennsylvania, USA

2 Department of Medical Education, St. Luke's University Health Network,
Bethlehem, Pennsylvania, USA

3 Department of Research and Innovation, St. Luke's University Health Network,
Bethlehem, Pennsylvania, USA

4 Department of Anesthesiology, The Ohio State University College of Medicine,
Columbus, Ohio, USA

*Address all correspondence to: stawicki.ace@gmail.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Rodier G. New rules on international public health security. *Bulletin of the World Health Organization*. 2007;85(6):428-430
- [2] Aldis W. Health security as a public health concept: A critical analysis. *Health Policy and Planning*. 2008;23(6):369-375
- [3] Chiu Y-W et al. The nature of international health security. *Asia Pacific Journal of Clinical Nutrition*. 2009;18(4):679
- [4] Bakanidze L, Imnadze P, Perkins D. Biosafety and biosecurity as essential pillars of international health security and cross-cutting elements of biological nonproliferation. *BMC Public Health*. 2010;10(1):S12
- [5] Programme UND. *Human Development Report*. New York: Oxford University Press; 1994. p. 1994
- [6] Scharoun K, Van Caulil K, Liberman A. Bioterrorism vs. health security—Crafting a plan of preparedness. *The Health Care Manager*. 2002;21(1):74-92
- [7] Heymann DL et al. Global health security: The wider lessons from the West African Ebola virus disease epidemic. *The Lancet*. 2015;385(9980):1884-1901
- [8] Reiter P et al. Global warming and malaria: A call for accuracy. *The Lancet Infectious Diseases*. 2004;4(6):323-324
- [9] Hobson C, Bacon P, Cameron R. *Human Security and Natural Disasters*. New York, NY: Routledge; 2014
- [10] Brown T. ‘Vulnerability is universal’: Considering the place of ‘security’ and ‘vulnerability’ within contemporary global health discourse. *Social Science & Medicine*. 2011;72(3):319-326
- [11] Kay A, Williams O. *Global Health Governance: Crisis, Institutions and Political Economy*. Hampshire, UK: Springer/Pallgrave Macmillan; 2009
- [12] Stawicki TT et al. From “pearls” to “tweets”: How social media and web-based applications are revolutionizing medical education. *International Journal of Academic Medicine*. 2018;4(2):93
- [13] Miller D et al. What is social media. How the World Changed Social Media. 2016;1:1-8
- [14] Boyd DM, Ellison NB. Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*. 2007;13(1):210-230
- [15] Taprial V, Kanwar P. *Understanding Social Media*. London, UK: Bookboon; 2012
- [16] Thackeray R et al. Adoption and use of social media among public health departments. *BMC Public Health*. 2012;12(1):242
- [17] McMillan SJ, Morrison M. Coming of age with the internet: A qualitative exploration of how the internet has become an integral part of young people’s lives. *New Media & Society*. 2006;8(1):73-95
- [18] Graham MW, Avery EJ, Park S. The role of social media in local government crisis communications. *Public Relations Review*. 2015;41(3):386-394
- [19] Jenkins H et al. *Confronting the Challenges of Participatory Culture: Media Education for the 21st Century*. Cambridge, MA: Mit Press; 2009
- [20] Hansen DL, Shneiderman B, Smith MA. *Analyzing Social Media Networks with NodeXL: Insights from a Connected World*. Burlington, MA: Morgan Kaufmann; 2010

- [21] Li H, Sakamoto Y. Social impacts in social media: An examination of perceived truthfulness and sharing of information. *Computers in Human Behavior*. 2014;**41**:278-287
- [22] Pavlíček A. Social Media—the Good, the Bad, the Ugly. IDIMT-2013. Prague, Czech Republic; 2013. p. 139
- [23] Wu L et al. Mining misinformation in social media. *Big Data in Complex and Social Networks*. 2016:123-152
- [24] Wasike J. Social media ethical issues: Role of a librarian. *Library Hi Tech News*. 2013;**30**(1):8-16
- [25] Scott PR, Jacka JM. *Auditing Social Media: A Governance and Risk Guide*. Hoboken, NJ: John Wiley & Sons; 2011
- [26] Goldsmith A. Disgracebook policing: social media and the rise of police indiscretion. *Policing and Society*. 2015;**25**(3):249-267
- [27] Goodman KW, Cushman R, Miller RA. Ethics in biomedical and health informatics: Users, standards, and outcomes. In: *Biomedical Informatics*. London, UK: Springer; 2014. pp. 329-353
- [28] Gritzalis D et al. History of information: the case of privacy and security in social media. In: *Proceedings of the History of Information Conference*. Athens, Greece: Athens University of Economics & Business; 2014
- [29] Potts L. *Social Media in Disaster Response: How Experience Architects Can Build for Participation*. Philadelphia, PA: Routledge; 2013
- [30] Bricout JC, Baker PM. Leveraging online social networks for people with disabilities in emergency communications and recovery. *International Journal of Emergency Management*. 2010;**7**(1):59-74
- [31] Imran M et al. Processing social media messages in mass emergency: A survey. *ACM Computing Surveys (CSUR)*. 2015;**47**(4):67
- [32] Castillo C. *Big Crisis Data: Social Media in Disasters and Time-Critical Situations*. Cambridge, England: Cambridge University Press; 2016
- [33] Korac-Boisvert N, Kouzmin A, et al. The dark side of info-age social networks in public organizations and creeping crises. *Administrative Theory & Praxis*. 1994:57-82
- [34] Bowdon MA. Tweeting an ethos: Emergency messaging, social media, and teaching technical communication. *Technical Communication Quarterly*. 2014;**23**(1):35-54
- [35] Flanagin AJ, Metzger MJ. Perceptions of Internet information credibility. *Journalism and Mass Communication Quarterly*. 2000;**77**(3):515-540
- [36] Johnson TJ, Kaye BK. Cruising is believing?: Comparing Internet and traditional sources on media credibility measures. *Journalism and Mass Communication Quarterly*. 1998;**75**(2):325-340
- [37] Flanagin AJ, Metzger MJ. The role of site features, user attributes, and information verification behaviors on the perceived credibility of web-based information. *New Media & Society*. 2007;**9**(2):319-342
- [38] Greer JD. Evaluating the credibility of online information: A test of source and advertising influence. *Mass Communication and Society*. 2003;**6**(1):11-28
- [39] Eastin MS. Credibility assessments of online health information: The effects of source expertise and knowledge of content. *Journal of Computer-Mediated Communication*. 2001;**6**(4):JCMC643

- [40] Bian J et al. Finding the right facts in the crowd: Factoid question answering over social media. In: Proceedings of the 17th International Conference on World Wide Web. Beijing, China. 2008
- [41] Knight GA, Cavusgil ST. Innovation, organizational capabilities, and the born-global firm. *Journal of International Business Studies*. 2004;**35**(2):124-141
- [42] Flanagin AJ, Metzger MJ. Digital media and youth: Unparalleled opportunity and unprecedented responsibility. Cambridge, MA: The MIT Press; 2008. pp. 5-28
- [43] Bakardjieva M, Feenberg A. Community technology and democratic rationalization. *The Information Society*. 2002;**18**(3):181-192
- [44] Shao G. Understanding the appeal of user-generated media: A uses and gratification perspective. *Internet Research*. 2009;**19**(1):7-25
- [45] Andreassen CS, Pallesen S, Griffiths MD. The relationship between addictive use of social media, narcissism, and self-esteem: Findings from a large national survey. *Addictive Behaviors*. 2017;**64**:287-293
- [46] Blackwell D et al. Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. *Personality and Individual Differences*. 2017;**116**:69-72
- [47] Monacis L et al. Social networking addiction, attachment style, and validation of the Italian version of the Bergen Social Media Addiction Scale. *Journal of Behavioral Addictions*. 2017;**6**(2):178-186
- [48] LaRose R, Kim J, Peng W. Social networking: Addictive, compulsive, problematic, or just another media habit? In: *A Networked Self*. Philadelphia, PA: Routledge; 2010. pp. 67-89
- [49] Homayoun A. The secret social media lives of teenagers. New York, NY: The New York Times Company. 2017;**7**:1-2
- [50] Khan ML. Social media engagement: What motivates user participation and consumption on YouTube? *Computers in Human Behavior*. 2017;**66**:236-247
- [51] Gunitsky S. Corrupting the cyber-commons: Social media as a tool of autocratic stability. *Perspectives on Politics*. 2015;**13**(1):42-54
- [52] Tavares S. Paratextual prometheus. Digital paratexts on YouTube, vimeo and prometheus transmedia campaign. *International Journal of Transmedia Literacy (IJTL)*. 2015;**1**:175-195
- [53] Pullen JP. How Vimeo became hipster YouTube. 2020 [07 January 2011]. Available from: <http://fortune.com/2011/02/23/how-vimeo-became-hipster-youtube/>
- [54] Brophy KM. Social media platform with gamification of user-generated content. 2017. Google Patents
- [55] Matejic N. Social Media Rules of Engagement: Why Your Online Narrative is the Best Weapon During a Crisis. Hoboken, NJ: John Wiley & Sons; 2015
- [56] Yazdani A, Lee J-S, Ebrahimi T. Implicit emotional tagging of multimedia using EEG signals and brain computer interface. In: Proceedings of the first SIGMM Workshop on Social Media. Beijing, China: ACM; 2009
- [57] Chen W, Lee K-H. Sharing, liking, commenting, and distressed? The pathway between Facebook interaction and psychological distress. *Cyberpsychology, Behavior and Social Networking*. 2013;**16**(10):728-734
- [58] Lee S-Y, Hansen SS, Lee JK. What makes us click “like” on

Facebook? Examining psychological, technological, and motivational factors on virtual endorsement. *Computer Communications*. 2016;**73**:332-341

[59] Meshi D, Tamir DI, Heekeren HR. The emerging neuroscience of social media. *Trends in Cognitive Sciences*. 2015;**19**(12):771-782

[60] Haituka SA et al. Live streaming broadcast service with artist and fan competitive reward system. 2016. Available from: <https://patents.google.com/patent/US20160007052A1/en> [Accessed: 22 July 2020]

[61] Davey CG et al. Being liked activates primary reward and midline self-related brain regions. *Human Brain Mapping*. 2010;**31**(4):660-668

[62] Sherman LE et al. What the brain 'Likes': Neural correlates of providing feedback on social media. *Social Cognitive and Affective Neuroscience*. 2018;**13**(7):699-707

[63] Balleine BW, Delgado MR, Hikosaka O. The role of the dorsal striatum in reward and decision-making. *Journal of Neuroscience*. 2007;**27**(31):8161-8165

[64] Achterberg M et al. Control your anger! The neural basis of aggression regulation in response to negative social feedback. *Social Cognitive and Affective Neuroscience*. 2016;**11**(5):712-720

[65] Sherman LE et al. Peer influence via instagram: Effects on brain and behavior in adolescence and young adulthood. *Child Development*. 2018;**89**(1):37-47

[66] Berryman C, Ferguson CJ, Negy C. Social media use and mental health among young adults. *Psychiatric Quarterly*. 2018;**89**(2):307-314

[67] Chambers D. Social Media and Personal Relationships: Online Intimacies and Networked Friendship.

Hampshire, UK: Springer/Palgrave Macmillan; 2013

[68] Comunello F, Anzera G. Will the revolution be tweeted? A conceptual framework for understanding the social media and the Arab Spring. *Islam and Christian-Muslim Relations*. 2012;**23**(4):453-470

[69] Child JT, Starcher SC. Fuzzy Facebook privacy boundaries: Exploring mediated lurking, vague-booking, and Facebook privacy management. *Computers in Human Behavior*. 2016;**54**:483-490

[70] Braithwaite DO, Suter EA, Floyd K. *Engaging Theories in Family Communication: Multiple Perspectives*. Philadelphia, PA: Routledge; 2017

[71] Grigg DW. Cyber-aggression: Definition and concept of cyberbullying. *Journal of Psychologists and Counsellors in Schools*. 2010;**20**(2):143-156

[72] Smith PK. Cyberbullying and cyber aggression. In: *Handbook of School Violence and School Safety*. Routledge; 2012. pp. 111-121

[73] Wright MF. Cyber victimization on college campuses: Longitudinal associations with suicidal ideation, depression, and anxiety. *Criminal Justice Review*. 2016;**41**(2):190-203

[74] Nevin AD. *Cyber-Psychopathy: Examining the Relationship Between Dark E-Personality and Online Misconduct*. London, Ontario: The University of Western Ontario; 2015. Available from: <https://ir.lib.uwo.ca/cgi/viewcontent.cgi?article=4531&context=etd>

[75] Buckels EE et al. Internet trolling and everyday sadism: Parallel effects on pain perception and moral judgment. *Journal of Personality*. 2019;**87**(2):328-340

[76] Jamison AM, Broniatowski DA, Quinn SC. Malicious actors on Twitter:

- A guide for public health researchers. *American Journal of Public Health*. 2019;109(5):688-692
- [77] Maltby J et al. Implicit theories of online trolling: Evidence that attention-seeking conceptions are associated with increased psychological resilience. *British Journal of Psychology*. 2016;107(3):448-466
- [78] Einarsen S, Aasland MS, Skogstad A. Destructive leadership behaviour: A definition and conceptual model. *The Leadership Quarterly*. 2007;18(3):207-216
- [79] Spector PE, Fox S. An emotion-centered model of voluntary work behavior: Some parallels between counterproductive work behavior and organizational citizenship behavior. *Human Resource Management Review*. 2002;12(2):269-292
- [80] Bradshaw S, Howard P. Troops, Trolls and Troublemakers: A Global Inventory of Organized Social Media Manipulation. 2017
- [81] Dredze M. How social media will change public health. *IEEE Intelligent Systems*. 2012;27(4):81-84
- [82] Schmidt CW. Trending now: Using social media to predict and track disease outbreaks. *Environmental Health Perspectives*. 2012;120(1):a30
- [83] Mackay IM, Arden KE. Middle East respiratory syndrome: An emerging coronavirus infection tracked by the crowd. *Virus Research*. 2015;202:60-88
- [84] Chunara R, Andrews JR, Brownstein JS. Social and news media enable estimation of epidemiological patterns early in the 2010 Haitian cholera outbreak. *The American Journal of Tropical Medicine and Hygiene*. 2012;86(1):39-45
- [85] Carter M. How Twitter may have helped Nigeria contain Ebola. *BMJ*. 2014;349:g6946
- [86] Schmidt CW. Trending Now: Using Social Media to Predict and Track Disease Outbreaks. National Institute of Environmental Health Sciences; 2012. Available from: https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.120-a30?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%20pubmed [Accessed: 23 July 2020]
- [87] Xie Y et al. Detecting and tracking disease outbreaks by mining social media data. In: Twenty-Third International Joint Conference on Artificial Intelligence. Evanston, IL: Northwestern University; 2013. Available from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.415.6200&rep=rep1&type=pdf> [Accessed: 23 July 2020]
- [88] Charles-Smith LE et al. Using social media for actionable disease surveillance and outbreak management: A systematic literature review. *PLoS One*. 2015;10(10):e0139701
- [89] Costa FF. Social networks, web-based tools and diseases: Implications for biomedical research. *Drug Discovery Today*. 2013;18(5-6):272-281
- [90] Chorianopoulos K, Talvis K. Flutrack. org: Open-source and linked data for epidemiology. *Health Informatics Journal*. 2016;22(4):962-974
- [91] Pelat C et al. More diseases tracked by using Google Trends. *Emerging Infectious Diseases*. 2009;15(8):1327
- [92] Carneiro HA, Mylonakis E. Google trends: A web-based tool for real-time surveillance of disease outbreaks. *Clinical Infectious Diseases*. 2009;49(10):1557-1564
- [93] Du RY, Hu Y, Damangir S. Leveraging trends in online searches for product features in market response modeling. *Journal of Marketing*. 2015;79(1):29-43

- [94] Zabin J, Brebach G. Precision Marketing: The New Rules for Attracting, Retaining, and Leveraging Profitable Customers. Hoboken, NJ: John Wiley & Sons; 2004
- [95] Dugas AF et al. Google Flu Trends: Correlation with emergency department influenza rates and crowding metrics. *Clinical Infectious Diseases*. 2012;54(4):463-469
- [96] Strzelecki A. Infodemiological Study Using Google Trends on Coronavirus Epidemic in Wuhan, China. arXiv preprint arXiv:2001.11021. 2020
- [97] Olson DR et al. Reassessing Google flu trends data for detection of seasonal and pandemic influenza: A comparative epidemiological study at three geographic scales. *PLoS Computational Biology*. 2013;9(10):e1003256
- [98] Analytica O. Coronavirus shows how China has changed since SARS. Emerald Expert Briefings, (oxan-db)
- [99] Chubin DE, Hackett EJ, Hackett EJ. Peerless Science: Peer Review and US Science Policy. Albany, NY: SUNY Press; 1990
- [100] Wilson EB. An Introduction to Scientific Research. New York, NY: Dover Publications, Inc.; 1990
- [101] Plaza M et al. The use of distributed consensus algorithms to curtail the spread of medical misinformation. *International Journal of Academic Medicine*. 2019;5(2):93
- [102] Sunstein CR. #Republic: Divided Democracy in the Age of Social Media. Princeton, NJ: Princeton University Press; 2018
- [103] Raboy M et al. Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation. Ann Arbor, MI: University of Michigan Press; 2008
- [104] Kietzmann JH et al. Social media? Get serious! Understanding the functional building blocks of social media. *Business Horizons*. 2011;54(3):241-251
- [105] Lagu T, Greysen SR. Physician, monitor thyself: professionalism and accountability in the use of social media. *The Journal of Clinical Ethics*. 2011;22(2):187-190
- [106] Vaidhyanathan S. The Anarchist in the Library: How the Clash Between Freedom and Control Is Hacking the Real World and Crashing the System. New York, NY: Basic Books; 2005
- [107] Kapoor KK et al. Advances in social media research: Past, present and future. *Information Systems Frontiers*. 2018;20(3):531-558
- [108] Aiken M. Cyber Effect: An Expert in Cyberpsychology Explains how Technology is Shaping Our Children, Our Behavior, and Our Values—and What We Can Do About It. New York, NY: Spiegel & Grau; 2017
- [109] Shirky C. The political power of social media: Technology, the public sphere, and political change. *Foreign Affairs*. 2011:28-41
- [110] Wood W, Wong FY, Chachere JG. Effects of media violence on viewers' aggression in unconstrained social interaction. *Psychological Bulletin*. 1991;109(3):371
- [111] Patton DU et al. Social media as a vector for youth violence: A review of the literature. *Computers in Human Behavior*. 2014;35:548-553
- [112] Kavanaugh AL et al. Social media use by government: From the routine to the critical. *Government Information Quarterly*. 2012;29(4):480-491
- [113] Ji X, Chun SA, Geller J. Epidemic outbreak and spread detection system based on Twitter data. In: *International*

Conference on Health Information Science. Berlin, Heidelberg, Germany: Springer; 2012

[114] Valente TW. Social Networks and Health: Models, Methods, and Applications. Vol. 1. New York: Oxford University Press; 2010

[115] Korda H, Itani Z. Harnessing social media for health promotion and behavior change. *Health Promotion Practice*. 2013;**14**(1):15-23

[116] Long JB, Ehrenfeld JM. The Role of Augmented Intelligence (AI) in Detecting and Preventing the Spread of Novel Coronavirus. *Journal of Medical Systems*. 2020;**44**:59

[117] Stephenson J. Coronavirus outbreak—An evolving global health emergency. *JAMA Health Forum*. 2020;**1**(2):e200114-e200114

[118] Bao Y et al. 2019-nCoV epidemic: Address mental health care to empower society. *The Lancet*. 2020

[119] Chen X et al. Why students share misinformation on social media: Motivation, gender, and study-level differences. *The Journal of Academic Librarianship*. 2015;**41**(5):583-592

[120] Shao C et al. Hoaxy: A platform for tracking online misinformation. In: *Proceedings of the 25th International Conference Companion on World Wide Web*. International World Wide Web Conferences Steering Committee; 2016. Available from: <https://arxiv.org/pdf/1603.01511.pdf,%C3%8F%E2%82%AC> [Accessed: 23 July 2020]

[121] Wilson M. The Hardest Job in the Silicon Valley is a Living Nightmare. 2018 [09 November 2018]. Available from: <https://www.fastcompany.com/90263921/the-hardest-job-in-silicon-valley-is-a-living-nightmare>

[122] Witt A, Suzor N, Huggins A. The rule of law on Instagram: An evaluation of the moderation of images depicting women's bodies. *UNSWLJ*. 2019;**42**:557

[123] Andreassen CS et al. The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors*. 2016;**30**(2):252

[124] Aardema F et al. Virtual reality induces dissociation and lowers sense of presence in objective reality. *Cyberpsychology, Behavior and Social Networking*. 2010;**13**(4):429-435

[125] Meyrowitz J. *No Sense of Place: The Impact of Electronic Media on Social Behavior*. New York, NY: Oxford University Press; 1986

[126] Skeels MM, Grudin J. When social networks cross boundaries: A case study of workplace use of Facebook and LinkedIn. In: *Proceedings of the ACM 2009 International Conference on Supporting Group Work*. 2009;**5**:95-104

[127] Bailenson JN et al. Equilibrium theory revisited: Mutual gaze and personal space in virtual environments. *Presence Teleoperators and Virtual Environments*. 2001;**10**(6):583-598

[128] Abril PS. A (My) space of one's own: on privacy and online social networks. *Northwestern Journal of Technology & Intellectual Property*. 2007;**6**:73

[129] Culotta A. Towards detecting influenza epidemics by analyzing Twitter messages. In: *Proceedings of the First Workshop on Social Media Analytics*. 2010;**7**:115-122

[130] Kass-Hout TA, Alhinnawi H. Social media in public health. *British Medical Bulletin*. 2013;**108**(1):5-24

[131] Brodeur J-P, Dupont B. Introductory essay: The role of knowledge and networks in policing.

- In: *The Handbook of Knowledge-Based Policing: Current Conceptions and Future Directions*. Chichester, West Sussex, England: John Wiley & Sons; 2008. pp. 9-36
- [132] Kumar S, Shah N. False Information on Web and Social Media: A Survey. arXiv preprint arXiv:1804.08559. 2018
- [133] Aronson RH, McMurtrie J. The use and misuse of high-tech evidence by prosecutors: Ethical and evidentiary issues. *Fordham Law Review*. 2007;**76**:1453
- [134] Alexander DE. Social media in disaster risk reduction and crisis management. *Science and Engineering Ethics*. 2014;**20**(3):717-733
- [135] Veil SR, Buehner T, Palenchar MJ. A work-in-process literature review: Incorporating social media in risk and crisis communication. *Journal of Contingencies & Crisis Management*. 2011;**19**(2):110-122
- [136] Wendling C, Radisch J, Jacobzone S. The Use of Social Media in Risk and Crisis Communication. 2013. Available from: https://www.oecd-ilibrary.org/governance/the-use-of-social-media-in-risk-and-crisis-communication_5k3v01fskip9s-en [Accessed: 23 July 2020]
- [137] Safieddine F, Dordevic M, Pourghomi P. Spread of misinformation online: Simulation impact of social media newsgroups. In: 2017 Computing Conference. IEEE; 2017. Available from: <https://ieeexplore.ieee.org/abstract/document/8252201> [Accessed: 23 July 2020]
- [138] Baker JP. Mercury, vaccines, and autism: one controversy, three histories. *American Journal of Public Health*. 2008;**98**(2):244-253
- [139] Hobson-West P. 'Trusting blindly can be the biggest risk of all': Organised resistance to childhood vaccination in the UK. *Sociology of Health & Illness*. 2007;**29**(2):198-215
- [140] Clarke CE. A question of balance: The autism-vaccine controversy in the British and American elite press. *Science Communication*. 2008;**30**(1):77-107
- [141] Link K. *The Vaccine Controversy: The History, Use, and Safety of Vaccinations*. Westport, CT: Greenwood Publishing Group; 2005
- [142] Dixon GN, Clarke CE. Heightening uncertainty around certain science: Media coverage, false balance, and the autism-vaccine controversy. *Science Communication*. 2013;**35**(3):358-382
- [143] Gross L. A broken trust: lessons from the vaccine-autism wars. *PLoS Biology*. 2009;**7**(5):e1000114
- [144] Brotherton R. *Suspicious Minds: Why We Believe Conspiracy Theories*. New York, NY: Bloomsbury Publishing; 2015
- [145] Kramer RM, Cook KS. *Trust and Distrust in Organizations: Dilemmas and Approaches*. New York, NY: Russell Sage Foundation; 2004
- [146] Holmberg C. Politicization of the LOW-CARB HIGH-FAT Diet in Sweden, promoted on social media by non-conventional experts. *International Journal of E-Politics (IJEP)*. 2015;**6**(3): 27-42
- [147] Jang K, Baek YM. When information from public health officials is untrustworthy: The use of online news, interpersonal networks, and social media during the MERS outbreak in South Korea. *Health Communication*. 2019;**34**(9):991-998
- [148] Tang L et al. Social media and outbreaks of emerging infectious diseases: A systematic review of literature. *American Journal of Infection Control*. 2018;**46**(9):962-972

- [149] Baccarella CV et al. Social media? It's serious! Understanding the dark side of social media. *European Management Journal*. 2018;**36**(4):431-438
- [150] Allcott H, Gentzkow M. Social media and fake news in the 2016 election. *Journal of Economic Perspectives*. 2017;**31**(2):211-236
- [151] Media Y. Swine Flu Conspiracy Theories. 2009 [28 April 2009]. Available from: <https://www.youtube.com/watch?v=C3fW82DbLKQ>
- [152] Today R. Swine Flu, Bird Flu 'Never Happened': Probe into H1N1 'False Pandemic'. 2018 [29 September 2010]. Available from: <https://www.youtube.com/watch?v=3haectEvDq0>
- [153] Labs Z. #211 Debate: FEMA Camps Trains Trucks Busses Coffins Swine Flu & Martial Law. 2009 [29 September 2018]. Available from: <https://www.youtube.com/watch?v=5I0eXsBqtlU>
- [154] Videos G. Google Search: "Swine Flu Epidemic". 2018 [cited 29 September 2018]. Available from: https://www.google.com/search?num=50&hl=en&tbm=vid&ei=UCewW47hNJCv5wLt7KG4Cw&q=%22swine+flu+epidemic%22&oq=%22swine+flu+epidemic%22&gs_l=psy-ab..0j0i30k1.5065.5719.0.5887.2.2.0.0.0.77.136.2.2.0....0...1c.1.64.psy-ab..0.2.134....0.LIBd3IoDxMA
- [155] Andrews P. China's new killer virus is mutated SARS & may be one more mutation away from infecting millions. Will it make the lethal leap? 2020
- [156] Taylor S. *The Psychology of Pandemics: Preparing for the Next Global Outbreak of Infectious Disease*. Newcastle, UK: Cambridge Scholars Publishing; 2019
- [157] Xiao B, Xiao L. Chinese Scientist Finds "Killer Coronavirus Probably Originated from a Laboratory in Wuhan". Available from: <https://www.zerohedge.com/health/smoking-gun-chinese-scientist-finds-killer-coronavirus-probably-originated-laboratory-wuhan> [Accessed: 23 July 2020]
- [158] Xiao B, Xiao L. Smoking gun? Chinese scientist finds "Killer coronavirus probably originated from a laboratory in Wuhan". *SAT*. 2020;**10**:44
- [159] Vijaykumar S, Jin Y, Nowak G. Social media and the virality of risk: The risk amplification through media spread (RAMS) model. *Journal of Homeland Security and Emergency Management*. 2015;**12**(3):653-677
- [160] Marwick AE, Boyd D. I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience. *New Media & Society*. 2011;**13**(1):114-133
- [161] Gerlitz C, Helmond A. The like economy: Social buttons and the data-intensive web. *New Media & Society*. 2013;**15**(8):1348-1365
- [162] Lewis K, Gonzalez M, Kaufman J. Social selection and peer influence in an online social network. *Proceedings of the National Academy of Sciences*. 2012;**109**(1):68-72
- [163] Harlow S. Social media and social movements: Facebook and an online Guatemalan justice movement that moved offline. *New Media & Society*. 2012;**14**(2):225-243
- [164] Pawar M. Resurrection of traditional communities in postmodern societies. *Futures*. 2003;**35**(3):253-265
- [165] Cao X. What Speech Should Be Outside of Freedom of Expression? 2010. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1733441 [Accessed: 23 July 2020]
- [166] Langvardt AW. Not on our shelves: A first amendment analysis of library censorship in the public schools. *Nebraska Law Review*. 1982;**61**:98

- [167] Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*. 2010;**53**(1):59-68
- [168] Clinton H. Internet Rights and Wrongs: Choices & Challenges in a Networked World. US State Department; 2011. Available from: http://diritto-comunicazione.decesare.info/Hillary-Clinton_George-Washington-Univ_15_02_11.pdf [Accessed: 23 July 2020]
- [169] Barberá P. How social media reduces mass political polarization. In: Evidence from Germany, Spain, and the US. Job Market Paper. New York University; 2014. p. 46. Available from: <http://rubenson.org/wp-content/uploads/2015/10/barbera-tpbw.pdf> [Accessed: 23 July 2020]
- [170] Starvridis J. Convergence: Illicit Networks and National Security in the Age of Globalization. Washington, D.C.: Government Printing Office; 2013
- [171] Svete U. European E-readiness? Cyber dimension of national security policies. *Journal of Comparative Politics*. 2012;**5**(1):38-59
- [172] Aliyev H. Precipitating state failure: do civil wars and violent non-state actors create failed states? *Third World Quarterly*. 2017;**38**(9):1973-1989
- [173] Chen D. "Supervision by public opinion" or by government officials? Media criticism and central-local government relations in China. *Modern China*. 2017;**43**(6):620-645
- [174] Enikolopov R, Petrova M, Sonin K. Social media and corruption. *American Economic Journal: Applied Economics*. 2018;**10**(1):150-174
- [175] Enikolopov R, Petrova M, Sonin K. Do Political Blogs Matter?: Corruption in State-controlled Companies, Blog Postings, and DDoS Attacks. Princeton, NJ: Centre for Economic Policy Research; 2012
- [176] Myers DP. Violation of treaties: Bad faith, nonexecution and disregard. *American Journal of International Law*. 1917;**11**(4):794-819
- [177] Fuchs C. Social Media: A Critical Introduction. Los Angeles, CA: Sage; 2017
- [178] Korta SM. Fake News, Conspiracy Theories, and Lies: An Information Laundering Model for Homeland Security. Monterey, California: Naval Postgraduate School; 2018
- [179] Ting CSW, Song SGZ. What Lies Beneath the Truth: A Literature Review on Fake News, False Information and More. 2018 [28 October 2017]. Available from: https://lkyspp.nus.edu.sg/docs/default-source/ips/report_what-lies-beneath-the-truth_a-literature-review-on-fake-news-false-information-and-more_300617.pdf
- [180] Fuchs C, Trottier D. Theorising Social Media, Politics and the State: An Introduction, in *Social Media, Politics and the State*. New York, NY: Routledge; 2014. pp. 15-50
- [181] Cohen E. Mass Surveillance and State Control: The Total Information Awareness Project. New York, NY: Springer; 2010
- [182] Castells M. Networks of Outrage and Hope: Social Movements in the Internet Age. Malden, MA: John Wiley & Sons; 2015
- [183] Fox NJ. Foucault, Foucauldians and sociology. *British Journal of Sociology*. 1998:415-433
- [184] White D. Public Discours: Importance & Strategies. 2018 [28 October 2018]. Available from: <https://study.com/academy/lesson/public-discourse-importance-strategies.html>

- [185] Wolf R. Immigration, Gay Rights, Politics, Abortion, Taxes, Technology: Crunch Time at the Supreme Court. 2018 [28 October 2018]. Available from: <https://www.usatoday.com/story/news/politics/2018/04/29/immigration-gay-rights-politics-abortion-taxes-technology-supreme-court/518748002/>
- [186] PublicHealth.org. Vaccine Myths Debunked. 2018 [28 October 2018]. Available from: <https://www.publichealth.org/public-awareness/understanding-vaccines/vaccine-myths-debunked/>
- [187] Richey M. Contemporary Russian revisionism: understanding the Kremlin's hybrid warfare and the strategic and tactical deployment of disinformation. *Asia Europe Journal*. 2018;**16**(1):101-113
- [188] Dwoskin E. Facebook Profit Hits an All-time High, Unaffected by Recent Scandals—So Far. 2018 [28 October 2017]. Available from: https://www.washingtonpost.com/news/the-switch/wp/2018/04/25/facebook-profit-hits-an-all-time-high-unaffected-by-recent-scandals-so-far/?noredirect=on&utm_term=.ac014b07938e
- [189] WHO. Strengthening Health Security by Implementing the International Health Regulations (2005): IHR Procedures Concerning Public Health Emergencies of International Concern (PHEIC). 2018 [28 October 2018]. Available from: <http://www.who.int/ihr/procedures/pheic/en/>
- [190] Chou W-YS, Oh A, Klein WM. Addressing health-related misinformation on social media. *JAMA*. 2018;**320**(23):2417-2418
- [191] Briggs CL. *Stories in the Time of Cholera: Racial Profiling during a Medical Nightmare*. Los Angeles, CA: University of California Press; 2003
- [192] Berlant L. Slow death (sovereignty, obesity, lateral agency). *Critical Inquiry*. 2007;**33**(4):754-780
- [193] Bickerstaff K, Simmons P, Pidgeon N. Situating local experience of risk: Peripherality, marginality and place identity in the UK foot and mouth disease crisis. *Geoforum*. 2006;**37**(5):844-858
- [194] Papadimos TJ et al. Ethics of outbreaks position statement. Part 2: Family-centered care. *Critical Care Medicine*. 2018;**46**(11):1856-1860
- [195] Papadimos TJ et al. Ethics of outbreaks position statement. Part 1: Therapies, treatment limitations, and duty to treat. *Critical Care Medicine*. 2018;**46**(11):1842-1855
- [196] Andrejevic M. *Infoglut: How Too Much Information Is Changing the Way We Think and Know*. New York, NY: Routledge; 2013
- [197] Shoemaker PJ, Reese SD. *Mediating the Message in the 21st Century: A Media Sociology Perspective*. New York, NY: Routledge; 2013
- [198] Arendt H. *The Human Condition*. Chicago, IL: University of Chicago Press; 2013
- [199] Kickbusch I, Leung G. Response to the Emerging Novel Coronavirus Outbreak. *British Medical Journal*. 2020;**368**:m406
- [200] Library of Congress Law. *Government Responses to Disinformation on Social Media Platforms: Comparative Summary*. 2020. Available from: <https://www.loc.gov/law/help/social-media-disinformation/compsum.php> [Accessed: 16 June 2020]

Health Security and the Refugee Crisis in Greece: The Refugee Perspective

*Thomas Papadimos, Scott Pappada, Michael Lyaker,
James Papadimos and Andrew Casabianca*

Abstract

The flight of refugees has been part of the human condition since the beginning of time. Recent events in the Middle East have caused a mass migration of refugees from Syria, Iraq, and Afghanistan. Their primary destination has been Europe, more specifically, the affluent, better industrialized countries of central and northern Europe. However, the European law currently requires that refugees must be processed at the first port of entry to Europe. In most cases, this involves the eastern Aegean Sea islands of Greece. Here the refugee camps have become overcrowded and underfunded, and have little medical care and security. The Greek government has limited resources and the response for support from the more affluent European countries has been underwhelming. Here we summarize the lack of health security from the refugee perspective of those that are awaiting entry to Europe and are encamped in Greece.

Keywords: human migration, Greece, public health, refugees, refugee camps

1. Introduction

The early to mid-twenty-first century will be known for its mass migration movements. In fact, Greece has become the gateway for the mass migrations of refugee populations since the end of World War II [1]. The current Middle East refugee crisis is taxing many national health care systems [2, 3]. Greece is in a particularly unique position regarding the flood of refugees into Europe because of their proximity to Turkey, which is the conduit for Syrian, Afghan, Kurdish, Iraqi, and in some cases, African refugees. Greece is not a stranger to refugees. In 1922, Greece experienced a massive inflow of Greek refugees fleeing Asia Minor after Greece's military defeat at the hands of Turkey. The Greek nation absorbed them successfully and in the 1990s was able to face a similar, but smaller refugee challenge with the migration of many people from Eastern Europe [4]. However, the current refugee problem, that is a consequence of the conflicts in the Middle East, is different; it involves a tidal wave of refugees that are of non-Greek origin. This was, and remains, a challenge for a homogenous society [5]. The challenge of supporting refugees is especially difficult in the context of the recent Greek debt crisis of 2008 that left the Greek economy devastated. The term migrant many times refers to economic status and can be considered derogatory, whereby they are not given the

consideration or status of refugees. In our work, we use the terms interchangeably and do not cast aspersions on those who are not truly refugees as defined by the 1952 United Nations Convention relating to the Status of Refugees (and the 1967 Protocol relating to the Status of Refugees).

Even before the debt crisis, there was a notion that Greece was not a safe host country for refugees [6]. Skordas and Sitaropoulos indicated that while the Greeks generally observed *non-refoulement* (the practice not mandating asylum seekers/refugees to return to a country in which they are liable to be persecuted), the Greek system of asylum suffered from a “calculated ambivalence towards the legal situation of the victims of non-state agents” and failed to provide for “basic subsistence needs ... and social protection for refugees and asylum seekers [6].” Despite Greece being on the receiving end of wave of refugees/migrants, the national policies were reactive with the occasional passing of ad hoc laws, executive decrees and policies directed at the behest of the European Economic Union (EU). These measures did not take into consideration the long-term view [7, 8]. Additionally, oppressive austerity initiatives forced on the Greeks by the EU have triggered “resistance” initiatives across the country making refugee-friendly positions/responses less likely [4]. In spite of these internal and external factors, the Greek nation, through anti-racist efforts and solidarity movements, managed to provide refugees with legal services, shared information regarding available social programs Greek language instruction and basic elements of health care [4, 9].

However, in 2015 a breaking point was reached. The conflicts in the Middle East resulted in more than 1,000,000 refugees arriving in Greece over a period of approximately 15 months [10]. This happened at the same time that the debt crisis was exacting a devastating toll on the Greek economy. Millions of people were leaving their home countries to find a safer place to relocate [11]. Most of these refugees were trying to get to central and northern Europe, through the route from Turkey to Greece [12]. However, the closure of the Western Balkans transit route on the border of Greece and the Former Yugoslav Republic of Macedonia in February/March 2016 (EU-Turkey agreement), transformed Greece “from a transit country to a country hosting tens of thousands of third-country nationals for a still undefined, yet long-term, period. Greece progressed from the logic of repression (meaning to keep all foreigners out) to the logic of reception,” and received 90% of the total population of refugees from 2016 to 2018 [9]. This resulted in between 10,000 and 20,000 asylum seekers who were unable to leave Greece and becoming confined to refugee camps where they were trapped and forced to live under poor economic and health conditions [13, 14]. Over time, this number has now swollen to over 60,000 people [15]. In effect, since 2011 one half of the Syrian population has been displaced, either as refugees to another country or internally (secondary to conflict, poverty, food insecurity or loss of infrastructure) [16]. Herein, we will review the multitude of public health and medical problems that dominate the health security of refugees in Greece. These problems include infectious diseases, mental health, women’s health issues, traumas and burns, and children’s health issues.

2. Methods

Using key words and the MESH headings provided by PubMed the authors reviewed the available papers and the determined which papers were the most relevant for the project. Additionally, key words were entered into Google Scholar resulting in further identification of source material; this included various forms of media and journalism. At the same time, documents originating with the United Nations and World Health Organization were also identified and reviewed.

3. Infectious diseases

3.1 Respiratory conditions

Refugees arriving to Greece may be vulnerable to infectious diseases because of poor nutritional status, unsafe drinking water in their journeys, lack of vaccination, poor or overcrowded living conditions, and lack of immunity to endemic diseases [17]. These factors can occur in transit, or in the country of origin [17, 18]. Because of this host countries may have serious concerns about the spread of disease by refugees/migrants. While there is little evidence to indicate that refugees spread disease to local populations (EU/EEA), conclusive data is lacking. Work done by Rojek et al., evaluating prospective data from medical consultations on patients presenting with symptoms and signs of a syndrome that may have warranted inclusion in a syndromic surveillance system, showed that fewer than 5% of patients had a full set of vital signs documented [17]. Also, only 11% of patients with a possible syndrome were reported to the medical alert system. Such gaps indicate that refugee patients may not be asked for a medical history, or be given an appropriately complete physical examination. Consequently, the risk of infectious diseases in refugee populations and the chance of disease entry into local populations may be underestimated [17].

Respiratory infections are of great concern and are the most frequent problem [17]. Medecins Sans Frontieres (MSF) clinics at the point of entry into Greece and Serbia found that respiratory tract infections (RTI) occurred in 41% of refugees. Clinics at the Greek-Turkish border exhibited an RTI prevalence of 23% [19, 20]. Refugees in Turkey had 330,000 excess cases of RTI and 50,000 excess cases of diarrhea in 2015 [21].

The unprecedented cross border mobility of refugees/migrants and refugees lends to the dissemination of multi-drug resistant (MDR) pathogens across borders. MDR organisms are often carried by young men (wounded in combat or as innocent by-standers). These individuals often find their way into camps where conditions contribute to the spread of pathogens with antibiotic resistance [22]. Although available evidence is sparse, there are indications that refugees admitted to healthcare facilities frequently import MDRs [23].

In a recent report by Hermans et al. regarding the disease burden among those staying at the Lesbos, Greece refugee camp, no reported cases of tuberculosis were identified [24]. However, 15.3% of Syrian refugees screened in Berlin had potentially contagious diseases [25]. This suggests that refugees entering Greece may have had inadequate diagnostic work-ups either due to a lack of medical expertise or money to do the testing. With the ongoing Syria humanitarian crisis infectious disease will continue to emerge and reemerge [26].

3.2 Hepatitis

As far back as 2003 Greek investigators had determined that refugees living in Athens (especially those from Asia and Albania) had a high incidence of hepatitis B viral (HBV) infection. Of note, the incidence of hepatitis C viral (HCV) infection was low [27]. Refugee populations in Greece in the early 2000s were avoiding established shelters for the fear of being departed, therefore they lived in crowded conditions among their own immigrant groups [28]. Hepatitis A viral disease (HAV) in Greece has remained high at 17.1% among non-immunized children [29]. Recent data from the Greek Government demonstrated spikes in HAV disease from 2005 to 2008, after the migration of populations from the Middle East and Roma (Albanian and other Balkan Roma groups) populations. A second spike occurred

in 2016 and 2017 secondary to the current Syrian disaster. In December 2016, as the Syrian crisis was reaching a crescendo, refugees and asylum seekers residing in host facilities in Greece were demonstrating an increase, mostly in children under 15 years of age [30, 31].

3.3 Leishmania

More than one million refugees arrived in Greece between 2015 and 2016 from areas with endemic Leishmaniasis (Syria, Iraq, and Afghanistan). This disease has serious social and economic consequences in these areas [32]. Fotakis et al. uncovered an infection rate of *Phlebotomus* spp. sand flies in refugee camps that indicated an elevated risk to local populations [32]. A common-sense recommendation would be to provide refugees access to decent living conditions, good health education, effective vector control, and interdict local colonization of sand flies. Ongoing studies of refugee populations regarding epidemiology and disease transmission may be helpful.

3.4 Shigella

Shigella is endemic in many low-income countries. The massive influx of refugees to Greece puts local and incoming refugee populations at risk [33]. At a syndromic notification center in Athens, Greece in 2015/2016 a cluster of shigellosis cases was identified. All cases were multi-drug resistant, and a potential common source was not identified. All cases were typed; real-time typing is helpful for control methods and epidemiological inquiries.

The truth is simple, refugees are colonized by resistant organisms during their extended stays in refugee/migrant camps [33, 34]. There is a need for a European tracking system that can be used by all countries where diseases and syndromes are identified to allow documentation and prompt, effective intervention.

4. Mental health

To say that refugees experience stress is an understatement. They must deal with war, migration, oppression, forced detention, violence, and witness death and destruction [35, 36]. They suffer abuse from smugglers, criminals, and governments [37]. In 2016, 5096 individuals perished at sea [37]. In view of the afore-mentioned, refugees have many psychological and somatic complaints [38]. To document this violence towards Syrian refugees and its effect, MSF has supported camps in Greece, conducted a quantitative and qualitative research investigation at sites in Greece (Ritsona camp near Athens, Katskikas camp near Ioannina, and Samos). The study aimed to determine the levels and type of violence experienced by refugees in their home communities, during their journey, and during their stay abroad. It also looked at the types of perpetrators, and the prevalence of anxiety and other mental disorders [35]. MSF used the Refugee Health Screener 15 (RHS-15) as their investigative tool. They found that over 92% of the participants screened positive for anxiety. Up to 75% experienced a violent act in Syria and over half experienced a violent act on their journey to Greece. The violence, as expected, decreased from Syria to Turkey and from Turkey to Greece. However, there were violent acts reported in Greece [39]. Most refugees felt oppressed by daily stressful events such as poverty, poor housing, isolation, societal marginalization, and changes in family structure [40–42].

To further elucidate the plight of Syrian refugees in Greece, in particular, Poole et al. studied major depressive symptoms and risk factors [43]. It is of interest that most migrants are normally healthier than the host populations [44]; this is called the “healthy migrant effect.” However, refugees/migrants fleeing conflict zones are not, and they face an increased prevalence of mental health problems [45]. Major depressive disorder (MDD) undermines individual and family functionality, which is imperative for survival, resettlement, and acculturation [46, 47]. MDDs occurred in 44% of the population studied. Women had significantly increased odds of MDD. Globally, women have 50% more MDDs than men [48]. The prevalence of MDD did not differ by age or educational level; however, increased time of displacement and time in the asylum process in Greece seemed to increase the likelihood of MDD. The odds of MDD increased by 15% for each additional month an individual was in the asylum process. The prevalence of MDD was 10× higher in Syrian refugees than in Syrians in pre-conflict times and generally across the globe [49, 50]. There is some evidence that MDD may lessen as the time since leaving the area of conflict increases [51].

The destruction done to individuals, families, and the mental health infrastructure of countries that accept refugees, is cataclysmic and ongoing. This is only compounded by a lack of information about legal procedures and an uncertain future in the countries in which they are encamped [35].

5. Women’s health

The plight of refugee women is difficult and perilous [52, 53]. While most of the refugees coming to Greece and Europe from the Middle East were initially men, women have been making the difficult trip in increasing numbers since 2016 [54]. Global figures show that 80% of the refugees and internally displaced people are women and children [55]. The displacement of families because of war has led to insecurity and vulnerability. Women are subjected to violence in their conflict-ravaged countries, during migration out of their country, and after their arrival in camps and refugee centers at their destination [52, 53]. Sexual and gender-based violence (SGBV) has become a significant burden to refugee women.

In war zones the terror is very straight forward. Bombs fall, soldiers from all sides of a conflict (whether from the Islamic State of Iraq and Syria (ISIS), the Syrian army proper, or Syrian rebels) rape women, kill family members, and steal possessions [52]. Violence during their journey of escape and migration comes, for the most part, from those who are supposed to help them, or claim to help them. Clearly, women traveling alone or with children are extremely vulnerable; however, even women travelling with men also do not have absolute safety.

Frequently, women are first victimized at the hands of smugglers who offer to help them and their children get to Europe for a price that includes “transactional sex.” If transit to the European Union (EU) becomes more difficult due to the closing of more border crossings (EU—Turkish agreement of March 2016) [9] or the bombing/destruction of smuggler’s boats (as proposed by the United Nations for the transit of refugees) [56] it is “likely that the demand for smugglers, and the price that they ask for facilitating the passage into Europe will increase [52].” A second opportunity for violence occurs at the hands of Turkish police and coast guard as women and their families try to flee to Greece [52]. A third threat along the road of migration comes from fellow male travelers. Even after reaching refugee camps women are frequently frightened to leave their tents at night (or at any time) due to the threat of rape by men in the camp [52]. The stress of flight from a war zone

and life in a refugee camp may lead to both verbal and violence from husbands. Psychological stress leads to SGBV and intimate partner violence [53]. This type of violence is a manner in which to eliminate feeling of helplessness and many refugee communities experience it [57]. It is of interest that SGBV is a reaction to something dangerous post immediate conflict [53, 58]. In 2015, the organization UN Women estimated that 35% of women are physically abuse or raped at some time in their lives [59].

Two other factors have exacerbated the plight of refugee women: (1) there are no clear policies at their first destination point in the EU (or for that matter, at any intermediate or final destination point) regarding whom to report physical or sexually abuse and (2), as alluded to above, the lack of an adequate accommodations increases their insecurity [52]. The above difficulties are all complicated by the fact that there are no legal, regular routes of transit for refugees.

Once asylum seeking women refugees (ASWR) reach a destination outside their country of origin there are considerable barriers to the provision of health care [60]. The first barrier is the legal barrier. ASWR (and men and children) will have limited access to national health systems. Specifically, the sexual and reproductive health (SRH) rights of ASWR are often compromised because of their lack of knowledge on what their rights are and how to navigate the health care system of their host country. This may be compounded by a deficit of knowledge on the part of those who try to provide services to them [60]. A second barrier is one of geography. Refugees can be moved from camp to camp and find it difficult to develop a sense of trust regarding relief workers. A lack of trust and a discontinuity of care compromise an ASWR's SRH. A third barrier involves the differing administrative rules and regulations in host countries. Even those providing the health care do not know all the rules and regulations regarding refugees and what they may be entitled to [60]. Another barrier of significance, involves the socio-cultural aspects affecting an ASWR. Some cultures have strict gender roles, and some ASWR do not want to be examined by a male health care provider. Even in a situation where the woman is willing, their husband or extended family may object [61]. Simply disrobing to any extent or assuming a particular position for a physical examination can be challenging [37, 62]. The general mistrust by the refugee community of the host country is accentuated by the health provider's lack of awareness regarding the socio-cultural mores of the refugees. Finally, the economic barriers cannot be discounted. ASWR may not be able to find work, or may not be allowed to work by their husbands or family [60, 63, 64]. Janssens et al. points out that the merely the need to purchase contraceptives may be beyond an ASWR's reach because of cost [60].

Therefore, the provision of care for ASWR is anything but systematic and organized [65]. Through their journeys, the barriers they encounter, and the woeful inadequacies they confront in their host countries, ASWR are left with unaddressed or inadequately addressed serious issues such as adequate perinatal care, controlling their sexuality, depression, anxiety, discrimination, unmet health service needs, and even female genital mutilation in their host destination perpetrated by their male dominant culture [65]. ASWR are a group that needs local, regional, and national assistance from the host country. Healthcare providers must understand position of refugee women from every perspective and must endeavor to overcome barriers to respect and meaningful care.

6. Child health

The international public health community is concerned about childhood morbidity in the refugee camps of Greece. Kampouras et al. was one of the first groups

to investigate and report on the disease burden of camps among children [15]. They divided the illnesses that occurred over the winter of 2016–2017 into infectious and non-infectious categories. Children less than the age of 12 years were usually presented with infectious causes (nearly 81%). Infants, toddlers and children suffered from respiratory infections more frequently than adolescents and adults who tended to present with non-infectious diseases. The most common infections in younger patients included infections of the respiratory tract (67%), skin (23%), the gastrointestinal tract (6%), and the urinary tract (3%). Non-communicable diseases among the youngest were often due to disease of the gastrointestinal tract (20%), respiratory system (18%), surgical problems (13%), and allergies (10%). Infants had better health than children or toddlers. There was no association between illness and gender [15].

There is no doubt that non-breastfed infants are at a higher risk for infection, hospitalization and death than those who are breastfed [66]. Significantly, while 75% of the babies arriving in Lesbos, Greece, were breastfed, only 25% of those leaving Lesbos were still being breastfed. The reason behind this may be related to some non-government organizations (NGOs) giving out infant formula indiscriminately. Because refugee camps have problems with overcrowding and many of the refugees/migrants arriving at these camps are already in poor health the general hygienic conditions of the camps are not very good [67–69]. Therefore, once the breast-feeding stops, not only is the mother's immunity no longer passed on to the infant, but the use of formula is plagued by a lack of hot, clean water, poor sterilization of bottles and nipples and an unreliable supply of milk types.

This leads to a general concern for the growth and development of refugee children [70]. Growth abnormalities have been identified among Syrian refugees in Jordan and Lebanon, where acute malnutrition is low, but stunting of growth is high [71–73]. Stunting, defined as low height for age, usually occurs because of prolonged undernutrition or malnutrition as well as poor living conditions [70]. In addition to stunting micronutrient deficiencies and a lack of adequate mineral and vitamin supplementation (such as zinc, iron, and calcium) in children is also associated with increased mortality [70]. In 2016 Walpole et al. carried out a project in Northern Greece to assess this situation among refugee children [70]. They found a high prevalence of stunting among the children from 0-5 years of age (including infants). Walpole et al. reported that “a high body mass index in stunted children was a common finding raising concerns over long-term health outcomes and risk of non-communicable disease.” This is essentially caused by chronic malnutrition as opposed to acute malnutrition. The rates of stunting for children in camps in Northern Greece were twice as high as that found in Jordanian camps. The children were exposed to a high amount of carbohydrate and fat, and very little protein. Micronutrient deficiencies were likely attributable to factors such as inadequate dietary intake by pregnant and breastfeeding mothers. Because of this finding a recommendation has been made to the Greek government to supplement micronutrients to children under 5 years of age, pregnant women, and women who are breastfeeding [70].

To avert important childhood diseases and decrease childhood morbidity an effective vaccination program must also be put into place. Until the spring of 2017, vaccination of refugee/migrant children was primarily accomplished by NGOs collaborating with the Greek Ministry of Health (MOH) [74]. Unfortunately, not all camps were equally covered by NGOs administering vaccines. This was particularly noted in camps that used hostels, hotels, and apartments for housing. In the spring of 2016, the General Directorate of Public Health of the MOH took over all vaccination activities under a program entitled “PHILOS-Emergency health response to refugee crisis.” The program was implemented by the Hellenic Center for Disease

Control and Prevention, and was funded by the Asylum, Migration and Integration Fund of the European Union's Directorate-General for the Migration and Home Affairs.

In a one-year period from 2017 to 2018, PHILOS performed 57,615 vaccinations. This included 21,031 vaccinations for measles-mumps-rubella (MMR), 7341 for diphtheria-tetanus-pertussis (DPT), 7652 for poliomyelitis, 5938 for pneumococcal disease, 7179 for Haemophilus influenza type b and 8474 for hepatitis B. Unfortunately, vaccination coverage was still not consistent, and subsequent vaccination often dropped off. The rate of vaccination for the first MMR dose was greater than 80%. However, the follow-up dose dropped by nearly one half. For all other vaccines the rates were even lower. The rate of 50% for children aged 0–4 years had follow-up vaccine coverage fall to less than 25% [31]. While numbers of those vaccinated are available, the denominator remains elusive. The lack of “cultural mediators” among the refugee community was a large problem in follow through. This was compounded by refugees being moved between locations as some camps closed and other camps opened. Vaccinating refugee children must be a priority, because refugees have low baseline rates of immunization and encounter obstacles to getting adequate healthcare. While PHILOS had developed standard operating procedures and improved coordination of vaccination implementation, much more needs to be done for the refugee children in Greece.

While we have addressed the SGBV women/girls suffer above. Here we need to address the topic of street children in Greece and the sexual exploitation of refugee boys. While the problem with street children in Greece has been a topic of concern since, but not extensively researched, since the late 20th century (1990s) [75], the sexual exploitation of refugee boys is a particular and growing concern in the face of the refugee crisis currently exacerbated by the Syrian refugee crisis [76].

What is the definition of street children? Determining this can be difficult because the action and locations of children “in the street” are difficult to ascertain and evaluate [75]. There have been attempts at defining this term by the United Nations (UN), and the Council of Europe (CE). However, according to Atlantis et al. there is agreement that the term refers to “children and young people who have early street experience and who usually spend most of their time in the streets, in the sense that they use that location as the principal place of some of their main daily activities (such as working, eating, and sleeping) [75].” However, let us review the two primary definitions as provided by the UN and the CE. The UN definition is as follows:

“any boy or girl...for whom the street has become his/her abode and/or source of livelihood; and who is inadequately protected, supervised, or directed by responsible adults [77].”

The CE has a similar, but somewhat different definition:

“Street children are children under eighteen who, for longer or shorter periods, live in a street milieu. They are children who live wandering from place to place and who have their peer groups, and contacts in the street. Officially these children may have as their address their parents' home or an institution of social welfare. Most significantly, they have few or no contacts with those adults, parents, school, child welfare institutions, social services, with a duty toward them [78, 79].”

Why are these children in this position? Before the current immigration/refugee crisis, this was usually this is due to “family breakdown, unemployment, poverty, membership of a minority group, armed conflict, and natural disasters [75].”

While these reasons apply today, the vast majority of these days are due to armed conflict or threat of conflict and the above-mentioned reasons still apply, but are secondary to conflict. In 1986, world-wide estimates were as high as 80 million street children [79, 80]. The current crises in the Middle East and those of the Balkans in the 1990s, do not give hope to a lesser estimate from 30 years ago. Greece has an attraction for those fleeing the Middle East and Africa because of its location as a stepping stone into Europe, but it does not have the resources to adequately support the current flood of refugees.

In 1999–2002, most of the street children were male (75%) [75]. In the recent flood of refugees to Greece (2015), the situation has worsened (89%) [79, 80]. Freccero et al. enlighten us that the current immigration crisis “is increasingly defined by the unprecedented numbers of children crossing the Mediterranean Sea, many of whom are unaccompanied and separated children (UASCs) as defined by the United Nations High Commissioner for Refugees (UNHCR) and the Committee on the Rights of Children [81].” In 2015 90,000 UASCs applied for asylum in Europe, four times higher than the previous year, and in 2016 there were 63,000 (89% being male) [79, 82].

This has been a particular problem in Greece where a majority UASCs are between 14 and 17 years of age and are inadequately housed and accommodated [83]. Freccero et al. makes us aware that sexual exploitation is illegal in Greece and that Greece is a signatory of the Optional Protocol to the Convention on the Rights of the Child on the sale of Children, Child Prostitution and Child Pornography [76, 84]. Nonetheless, the high visibility of UASCs in public has led to increasing reports of teenage boys being exploited sexually by older men for money [84–88]. Young boys and teens are the majority of UASCs, and while institutions and governments have been appropriately concerned about girls and women, young male UASCs have been left without adequate responses to their plight. The Greeks have debated and given serious consideration to three approaches to prevention of this dilemma for male UASCs: (1) the use of secure shelters for prevention of abuse and protection, (2) improving life skills to empower better decision-making, and (3) direct cash distribution to the individual [76]. There are positive aspects to these proposals, however, there still remains much work to be done on their implementation, need for funding sources, and the subsequent evaluation of their effectiveness.

Gender-based violence programs for women have been sorely needed and some have been implemented. However, these young, male, UASCs must not be overlooked. Shelter, tools for survival, and guidance are necessary to ensure their welfare.

7. Violence in Greek refugee camps

Violence is on the increase in Greek refugee camps [89]. Gender-based violence has been addressed above. Disease, insects, cold, uncontrolled amounts of waste, impure water, congestion, and increased stress have led to violence in the camps through short tempers [89]. There are frequent clashes, riots, and incidence of violence, compounded by only 72 people per toilet and 84 people per shower [90]. Furthermore, Greece is struggling with a new refugee/migrant influx of 10,000 in October of 2019 and the camps are always at the breaking point [91]. The situation is so dire that children as young as 10 years of age are attempting suicide [92]. These problems in the camps and the increasing number of refugees has been compounded by “A combination of right-wing, populist narratives, a sluggish Greek economy and lack of tourism” on once popular Greek islands “have also affected

the sentiment of the locals towards migrants and refugees.” The communities that opened their doors in 2015 are no longer warm and receptive [91]. The possible of violence between refugees, between Greek citizens and refugees, and refugee suicide/suicide attempts remains disturbing. An international effort in support of the refugees and in support of the government of Greece is needed.

8. Human trafficking

Many of the previous sections spoke to the topic of human trafficking, sexual or otherwise, involving men, women, children and smugglers/traffickers. Here we would like to emphatically point out that the trafficking of people as refugees leaving, not only poverty, but violence, abuse of all kinds, and seeking political asylum because of the fear of reprisal, is common, almost unstoppable, and a stain on the human effort for justice and on the instruments and institutions of government.

Another term for mass migration/exodus of refugees/migrants can be termed “irregular movement.” In mass movements of migrants/refugees, there is little evidence as to when, why, and how such a susceptibility arises [93]. The reader may have noticed a “fluidity” in the terms of these different categories; there is neither a linear nor obvious trajectory between the identities of “migrant,” “refugee,” and “trafficking victim [93].” Trafficking could lead an individual to becoming a migrant/refugee, or sometimes migrants/refugees are trafficked in their flight from harm’s way. There are different types of exploitation for trafficking and this includes: trafficking for sexual exploitation, trafficking for labor exploitation, trafficking for the removal of organs, trafficking for criminal activity, trafficking for forced marriage, and trafficking for sexual and labor exploitation [93]. Those who are trafficked have particular vulnerabilities as pointed out by Brunovskis and Surtees: a paucity of resources, no legal status, inadequate knowledge regarding laws, rights, and assistance, barriers to language, lack of humanitarian aid availability, work scenarios that can lead to exploitation and abuse, threats to safety of self and family, and exposure to violence and abuse with communities and families [93].

Populations moving irregularly and/or migrants/refugees encamped for prolonged stays are extremely vulnerable to being trafficked. There is no State organization or instrument that can provide proper protection from exploitation. Efforts to protect migrant/refugees requires a multi-agency approach between regional, national, and international organizations, including “criminal justice, judicial engagement, human rights and development [94].”

9. Social determinants of disease

It is evident from the above discourse that social determinants of disease effect refugees/migrants. A person’s health is influenced by many factors, and these can be placed into five categories [95]. These categories include genetics, behavior, environmental and physical aspects, medical care, and social factors, i.e., social determinants of disease or health. In fact, migration, in and of itself, is a social determinant of disease [96]. Any meaningful endeavor to improve refugee health will depend on those who make policy and provide funding, as well as clinicians and public health officials and professionals. Movements of populations act as social determinants of disease of health in two ways. As previously stated, the first factor of just trying to get to safety or a better life through hostile areas presents a variety of health risks [97], and the second involves just being a refugee or migrant because this status “limits behavioral choices and, indeed, often directly impacts

and significantly alters the effect of other social positioning such as race/ethnicity, gender, or socioeconomic status, because it places individuals in ambiguous and often hostile relationships to the state and its institutions, including health services [98].”

The World Health Organization has created a Commission on the Social Determinants of Health in order to eliminate health inequities [95]. This commission wished to improve the daily life of populations, address the problems of distribution of power, money, and resources, and measure, evaluate, and act on these problems. This is a noble undertaking, however, if being a refugee or migrant is a social determinant of disease (and a significant one), then the policies and politics of war, religion, and genocide must be solved. This is a daunting, formidable, and seemingly insurmountable task at this time.

10. Conclusions

Many of the over one million refugees who have passed through Greece have been exposed to severe physical and mental trauma in their land of origin, on their routes of escape, and in the camps themselves. Their well-being necessitates physical security, food security, shelter, and a means of re-entering a safe society. More efforts are needed by the international community to ensure these necessities are put into place. More specifically, more attention must be directed to the security of women, girls, and male adolescents and their ultimate welfare, as well as encouraging refugees and migrants as to their rights as displaced people, services and legal options that are available to them. Furthermore, approaches to shelter, physical security, skill acquisition, and methods to assess and mitigate economic vulnerability must be pursued by institutions and governments. The dilemmas regarding the financial and manpower constraints of the Greek government in their ability to assist refugees and migrants must be addressed primarily by the EU and Middle Eastern nations in order to facilitate appropriate resolutions. These problems cannot simply be left at the doorstep of Greece. The ethics involving the plight of refugees and migrants in Greek camps require thoughtful and powerful approaches to resolve these difficult matters.

While the migrant/refugee problems related to Greece are highlighted here, it must be noted that there are still serious refugee matters in Syria (6.7 million refugees), Afghanistan (2.7 million refugees), South Sudan (2.3 million refugees), Myanmar (1.1 million refugees), and Somalia (0.9 million refugees), and these migrant/refugees face the same unenviable circumstances [99].

The authors hope that serious efforts are made on behalf of the refugees and migrants to ensure their well-being, while at the same time allotting resources to the Greek government so that the tasks that the European Union, the United States, and others expect the Greeks to execute can be accomplished in an efficient and empathetic fashion.

Author details

Thomas Papadimos^{1*}, Scott Pappada², Michael Lyaker¹, James Papadimos³
and Andrew Casabianca²

1 Department of Anesthesiology, Division of Critical Care Medicine, The Ohio State University Wexner Medical Center, Columbus, OH, USA

2 Department of Anesthesiology, The University of Toledo College of Medicine and Life Sciences, Toledo, USA

3 The University of Toledo College of Medicine and Life Sciences, Toledo, USA

*Address all correspondence to: thomas.papadimos@osumc.edu

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Gulland A. Global refugee total reached almost 60 million in 2014, highest since WWII. *BMJ*. 2015;**351**:h6478
- [2] Hunter P. The refugee crisis challenges national health care systems. *EMBO Reports*. 2016;**17**(4):492-495
- [3] Kotsiou O, Kotsios P, Srivastava D, Kotsios V, Gourgoulianis K, Exadaktylos A. Impact of the refugee crisis on the Greek healthcare system: A long road to Ithaca. *International Journal of Environmental Research and Public Health*. 2018;**15**(8):1790
- [4] Dedotsi S, Ioakimidis V, Teloni D-D. Refugee crisis in Greece: The development of racism, anti-racist responses and implications for social work. *Comunitania*. 2019;**17**:59-69
- [5] Voulgaridou MG, Papadopoulos RK, Tomaras V. Working with refugee families in Greece: Systemic considerations. *Journal of Family Therapy*. 2006;**28**(2):200-220
- [6] Skordas A, Sitaropoulos N. Why Greece is not a safe host country for refugees. *International Journal of Refugee Law*. 2004;**16**(1):25-52
- [7] Triandafyllidou A. Greek immigration policy at the turn of the 21st century. Lack of political will or purposeful mismanagement? *European Journal of Migration and Law*. 2009;**11**(2):159-177
- [8] Triandafyllidou A. Greek migration policy in the 2010s: Europeanization tensions at a time of crisis. *Journal of European Integration*. 2014;**36**(4):409-425
- [9] Tagiadou I, Baskozos I. The challenge of a comprehensive health response to the refugee crisis in Greece. In: *Refugee Migration and Health*. Cham, Switzerland: Springer; 2019. pp. 149-159
- [10] UNHCR. Peration Portal, “Mediterranean situation.” UNCHR. United Nations Refugee Agency; 2018. Available from: <https://data2.unhcr.org/en/situations/mediterranean>
- [11] Refugees UNHC. Global Trends: Forced Displacement in 2018. 2018. Available from: <https://www.unhcr.org/en-us/statistics/unhcrstats/5d08d7ee7/unhcr-global-trends-2018.html>
- [12] Frontieres MS. Crisis Update. 2016. Available from: <https://www.msf.org/syria-crisis-update-28-november-2016>
- [13] Frontieres MS. Don't Turn Your Back on Asylum. London, UK: Medecins Sans Frontieres; 2016. Available from: <https://www.msf.org/europe-dont-turn-your-back-asylum-takepeoplein>
- [14] Watch HR. Greece: 13,000 Still Trapped on Islands. 2018. Available from: <https://www.hrw.org/news/2018/03/06/greece-13000-still-trapped-islands>
- [15] Kampouras A, Tzikos G, Partsanakis E, Roukas K, Tsiamitros S, Deligeorgakis D, et al. Child morbidity and disease burden in refugee camps in mainland Greece. *Children*. 2019;**6**(3):46
- [16] Nations U. Syria at war: Five years on 2016. Available from: <https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/syria-war-five-years.pdf>
- [17] Rojek AM, Gkolfinopoulou K, Veizis A, Lambrou A, Castle L, Georgakopoulou T, et al. Clinical assessment is a neglected component of outbreak preparedness: Evidence from refugee camps in Greece. *BMC Medicine*. 2018;**16**(1):43
- [18] Kousoulis AA, Ioakeim-Ioannidou M, Economopoulos KP. Access to health

for refugees in Greece: Lessons in inequalities. *International Journal for Equity in Health*. 2016;**15**(1):122

[19] Eonomopoulou A, Pavli A, Stasinopoulou P, Giannopoulos LA, Tsiodras S. Migrant screening: Lessons learned from the migrant holding level at the Greek-Turkish borders. *Journal of Infection and Public Health*. 2017;**10**(2):177-184

[20] Evlampidou I. Refugee crisis in Europe: Health status, life experiences and mental health problems of transiting refugees and migrants on the Balkan route in 2015. *F1000Research*. 2016;5

[21] Doganay M, Demiraslan H. Refugees of the Syrian civil war: Impact on reemerging infections, health services, and biosecurity in Turkey. *Health Security*. 2016;**14**(4):220-225

[22] MacPherson DW, Gushulak BD, Baine WB, Bala S, Gubbins PO, Holtom P, et al. Population mobility, globalization, and antimicrobial drug resistance. *Emerging Infectious Diseases*. 2009;**15**(11):1727

[23] Maltezou HC, Theodoridou M, Daikos GL. Antimicrobial resistance and the current refugee crisis. *Journal of Global Antimicrobial Resistance*. 2017;**10**:75-79

[24] Hermans MP, Kooistra J, Cannegieter SC, Rosendaal FR, Mook-Kanamori DO, Nemeth B. Healthcare and disease burden among refugees in long-stay refugee camps at Lesbos, Greece. *European Journal of Epidemiology*. 2017;**32**(9):851-854

[25] Theuring SF-JB, Portner K, Trebesch I, Durst A, Dieckmann S, Steiner F, et al. Screening for infectious diseases among unaccompanied minor refugees in Berlin, 2014-2015. *European Journal of Epidemiology*. 2016;**31**(7):707-710

[26] Nimer NA. A review on emerging and reemerging of infectious diseases in Jordan: The aftermath of the Syrian crises. *Canadian Journal of Infectious Diseases and Medical Microbiology*. 2018;**2018**:8679174

[27] Roussos A, Goritsas C, Pappas T, Spanaki M, Papadaki P, Ferti A. Prevalence of hepatitis B and C markers among refugees in Athens. *World Journal of Gastroenterology: WJG*. 2003;**9**(5):993

[28] Ackerman LK. Health problems of refugees. *Journal of the American Board of Family Practice*. 1997;**10**(5):337-348

[29] Kyrka A, Tragiannidis A, Cassimos D, Pantelaki K, Tzoufi M, Mavrokosta M, et al. Seroepidemiology of hepatitis A among Greek children indicates that the virus is still prevalent: Implications for universal vaccination. *Journal of Medical Virology*. 2009;**81**(4):582-587

[30] Mellou K, Silvestros C, Saranti-Papasaranti E, Koustenis A, Pavlopoulou ID, Georgakopoulou T, et al. Increasing childhood vaccination coverage of the refugee and migrant population in Greece through the European programme PHILOS, April 2017 to April 2018. *Eurosurveillance*. 2019;**24**(27):1800326

[31] Mellou K, Sideroglou T, Papaevangelou V, Katsiaflaka A, Bitsolas N, Verykouki E, et al. Considerations on the current universal vaccination policy against hepatitis A in Greece after recent outbreaks. *PLoS One*. 2015;**10**(1):e0116939

[32] Fotakis EA, Giantsis IA, Avgerinou A, Kourtidis S, Agathaggelidou E, Kapoula C, et al. Identification of *Leishmania* species in naturally infected sand flies from Refugee Camps, Greece. *Emerging Infectious Diseases*. 2019;**25**(2):361

- [33] Georgakopoulou T, Mandilara G, Mellou K, Tryfinopoulou K, Chrisostomou A, Lillakou H, et al. Resistant shigella strains in refugees, August–October 2015. Greece. *Epidemiology & Infection*. 2016;**144**(11):2415-2419
- [34] Ali PHSF, Krcmery V, Jankechova M, Putekova S, Kabatova J, Tkacova L, et al. Migrants are colonized by resistant bacteria during their prolonged stays in refugee camps. *Clinical Social Work and Health Intervention*. 2017;**8**(1):15-18
- [35] Farhat JB, Blanchet K, Bjertrup PJ, Veizis A, Perrin C, Coulborn RM, et al. Syrian refugees in Greece: Experience with violence, mental health status, and access to information during the journey and while in Greece. *BMC Medicine*. 2018;**16**(1):40
- [36] Europe UNHCoRBf. Desperate Journeys-Refugees and migrants entering and crossing Europe via the Mediterranean and Western Balkan Routes. 2017. Available from: <https://www.unh/58b449f54.pdfcr.org>
- [37] Europe UBo. Desperate Journeys. 2017. Available from: <https://www.unh/58b449f54.pdfcr.org>
- [38] Hassan G, Ventevogel P, Jefee-Bahloul H, Barkil-Oteo A, Kirmayer L. Mental health and psychosocial wellbeing of Syrians affected by armed conflict. *Epidemiology and Psychiatric Sciences*. 2016;**25**(2):129-141
- [39] Nations U. More must be done to place Syrian refugees; conflict sees worst violence in months. 2017. Available from: <https://refugeesmigrants.un.org/ar/node/100043137>
- [40] Miller KE, Omidian P, Rasmussen A, Yaqubi A, Daudzai H. Daily stressors, war experiences, and mental health in Afghanistan. *Transcult Psychiatry*. 2008;**45**(4):611-638
- [41] Fernando GA, Miller KE, Berger DE. Growing pains: The impact of disaster-related and daily stressors on the psychological and psychosocial functioning of youth in Sri Lanka. *Child Development*. 2010;**81**(4):1192-1210
- [42] Miller KE, Rasmussen A. War exposure, daily stressors, and mental health in conflict and post-conflict settings: Bridging the divide between trauma-focused and psychosocial frameworks. *Social Science & Medicine*. 2010;**70**(1):7-16
- [43] Poole DN, Hedt-Gauthier B, Liao S, Raymond NA, Bärnighausen T. Major depressive disorder prevalence and risk factors among Syrian asylum seekers in Greece. *BMC Public Health*. 2018;**18**(1):908
- [44] Zimmerman C, Kiss L, Hossain M. Migration and health: A framework for 21st century policy-making. *PLoS Med*. 2011;**8**(5):e1001034
- [45] Fazel M, Wheeler J, Danesh J. Prevalence of serious mental disorder in 7000 refugees resettled in western countries: A systematic review. *Lancet*. 2005;**365**(9467):1309-1314
- [46] Yoon E, Chang C-T, Kim S, Clawson A, Cleary SE, Hansen M, et al. A meta-analysis of acculturation/enculturation and mental health. *Journal of Counseling Psychology*. 2013;**60**(1):15
- [47] Ventevogel P, van Ommeren M, Schilperoord M, Saxena S. Improving mental health care in humanitarian emergencies. *SciELO Public Health*. 2015. p. 666-667
- [48] Organization WH. The Global Burden of Disease: 2004. 2004. Available from: https://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/

- [49] Kilzieh N, Rastam S, Ward KD, Maziak W. Gender, depression and physical impairment: An epidemiologic perspective from Aleppo, Syria. *Social Psychiatry and Psychiatric Epidemiology*. 2010;**45**(6):595-602
- [50] Ferrari AJ, Charlson FJ, Norman RE, Patten SB, Freedman G, Murray CJ, et al. Burden of depressive disorders by country, sex, age, and year: Findings from the global burden of disease study 2010. *PLoS Medicine*. 2013;**10**(11):e1001547
- [51] Steel Z, Silove D, Brooks R, Momartin S, Alzuhairi B, Susljik I. Impact of immigration detention and temporary protection on the mental health of refugees. *The British Journal of Psychiatry*. 2006;**188**(1):58-64
- [52] Freedman J. Sexual and gender-based violence against refugee women: A hidden aspect of the refugee "crisis". *Reproductive Health Matters*. 2016;**24**(47):18-26
- [53] Jensen MA. Gender-based violence in refugee camps: Understanding and addressing the role of gender in the experiences of refugees. *Inquiries Journal*. 2019;**11**(02)
- [54] Refugees UNHCo. *Forced Global Displacement 2016*. 2016. Available from: <https://www.unhcr.org/globaltrends2016/>
- [55] Qayum MMS, Arooj H. Frequency and physical factors associated with gender-based violence in the internally displaced people of Pakistan. *Journal of the College of Physicians and Surgeons Pakistan*. 2012;**22**(1):63-65
- [56] Sengupta S. UN wants to let Europe use military force to stop smuggling boats. *New York Times*. 2015. Available from: <https://www.nytimes.com/2015/05/07/world/europe/un-wants-to-let-europe-use-military-force-to-stop-migrant-smuggling-boats.html>
- [57] Jasinski JL. Theoretical explanations for violence against women. In: Renzetti CM, Edleson JL, Bergen RK, editors. *Sourcebook on Violence Against Women*. London: Sage Publications; 2001. pp. 5-21
- [58] Littlewood R. Militaray rape. *Anthropology Today*. 1997;**13**(2):7-16
- [59] Chakrabarti S. *Of Women: In the Twenty-First Century*. London: Alan Lane; 2017
- [60] Janssens K, Bosmans M, Leye E, Temmerman M. Sexual and reproductive health of asylum-seeking and refugee women in Europe: Entitlements and access to health services. *Journal of Global Ethics*. 2006;**2**(2):183-196
- [61] Ascoly N, Van Halsema I, Keyzers L. Refugee women, pregnancy, and reproductive health care in the Netherlands. *Journal of Refugee Studies*. 2001;**14**(4):371-393
- [62] Mestheneos E, Ioannidi-Kapolou E, Gaunt S. *Refugee Perceptions of Integration in the European Union*. Groupe de travail sur l'intégration du CERÉ. *Bridges and Fences: Bruxelles, OCIV; 1999*
- [63] Stronks K, Venema PU, Dahhan N, Gunning-Schepers L. ARTIKELEN- Allochtoon, dus ongezond?-Mogelijke verklaringen voor de samenhang tussen etniciteit en gezondheid geïntegreerd in een conceptueel model. *TSG-Tijdschrift voor Gezondheidswetenschappen*. 1999;**77**(1):33-40
- [64] Bartels K. *Gezondheidstoestand*. In: Grotenhuis R, editors. *Van pionieren tot verankeren. Tien jaar gezondheidszorg voorvluchingen*. Utrecht: Pharos; 2003. p. 115-159
- [65] Gagnon AJ, Merry L, Robinson C. A systematic review of refugee women's reproductive health. *Refuge: Canada's Journal on Refugees*. 2002;**21**(1):6-17

- [66] Gribble KD, McGrath M, MacLaine A, Lhotska L. Supporting breastfeeding in emergencies: Protecting women's reproductive rights and maternal and infant health. *Disasters*. 2011;**35**(4):720-738
- [67] Soares AA, Tzafalias M. Europe gears up to attend to refugees' health. *Bulletin of the World Health Organization*. 2015;**93**(12):822-823
- [68] Bloch-Infanger C, Bättig V, Kremo J, Widmer AF, Egli A, Bingisser R, et al. Increasing prevalence of infectious diseases in asylum seekers at a tertiary care hospital in Switzerland. *PLoS One*. 2017;**12**(6):e0179537
- [69] Pavli A, Maltezou H. Health problems of newly arrived migrants and refugees in Europe. *Journal of Travel Medicine*. 2017;**24**(4):1-8
- [70] Walpole S, Abbara A, Gunst M, Harkensee C. Cross-sectional growth assessment of children in four refugee camps in Northern Greece. *Public Health*. 2018;**162**:147-152
- [71] Bilukha OO, Jayasekaran D, Burton A, Faender G, King'ori J, Amiri M, et al. Nutritional status of women and child refugees from Syria-Jordan, April-May 2014. *Morbidity and Mortality Weekly Report*. 2014;**63**(29):638-639
- [72] Hossain SM, Leidman E, Kingori J, Al Harun A, Bilukha OO. Nutritional situation among Syrian refugees hosted in Iraq, Jordan, and Lebanon: Cross sectional surveys. *Conflict and Health*. 2016;**10**:26
- [73] Refugees UNHCo. Technical fact sheet: Nutrition situation-Syrian refugees response in Jordan. United Nations; 2014. Available from: <https://data2.unhcr.org/en/situations/syria?od=7202>
- [74] Mellou K, Chrisostomou A, Sideroglou T, Georgakopoulou T, Kyritsi M, Hadjichristodoulou C, et al. Hepatitis A among refugees, asylum seekers and migrants living in hosting facilities, Greece, April to December 2016. *Eurosurveillance*. 2017;**22**(4):30448
- [75] Altanis P, Goddard J. Street children in contemporary Greece. *Children & Society*. 2004;**18**(4):299-311
- [76] Freccero J, Biswas D, Whiting A, Alrabe K, Seelinger KT. Sexual exploitation of unaccompanied migrant and refugee boys in Greece: Approaches to prevention. *PLoS Medicine*. 2017;**14**(11):e1002438
- [77] Forum on Street Children and Youth. Grand Bassam, Ivory Coast: International Catholic Children's Fund; 1985
- [78] Report F. Research Programme in the Social Field of Study: Group on Street Children. Strousbourg: Council of Europe; 1994
- [79] Kurz G. Asylum applicants considered to be minors: Eurostat. 2018. Available from: <https://ec.europa.eu/eurostat/documents/2995521/8895109/3-16052018-BP-EN.pdf/ec4cc3d7-c177-4944-964f-d85401e55ad9>
- [80] UNICEF. Exploitation of working children and street children Florence Italy. 1986
- [81] Rights of the Child Comment No. 6. Geneva: United Nation Committee on the Rights of the Child; 2005
- [82] Asylum applicants considered to be minors. Eurostat; 2017. Available from: <https://ec.europa.eu/eurostat/en/web/products-datasets/-/TPS00194>
- [83] United Nations High Commissioner for Refugees. Regional Refugee and Migrant Respose Plan for Europe. 2017. Available from: <https://data2.unhcr.org/en/documents/download/52619>

- [84] Optional Protocol to the convention on the Rights for the Child on the sale of children, child prostitution and child pornography: United Nations Office of the High Commissioner; 2000. Available from: <https://www.ohchr.org/EN/ProfessionalInterest/Pages/OPSCCRC.aspx>
- [85] Digidiki V. A harsh New Reality: Transactional Sex Among Refugee Minors As a Means of Survival in Greece. Boston; 2016. Available from: <https://fxb.harvard.edu/2016/12/17/a-harsh-new-reality-transactional-sex-among-refugee-minors-as-a-means-of-survival-in-greece/>
- [86] Damon A. The teenage refugees selling sex on Athens Streets CNN; 2017. Available from: <https://www.cnn.com/2016/11/29/europe/refugees-prostitution-teenagers-athens-greece/index.html>
- [87] Karas T. Young, Alone, Abused: Unaccompanied Minors Wish They Had Never Come to Greece: The New Humanitarian; 2016. Available from: <https://www.ohchr.org/EN/ProfessionalInterest/Pages/OPSCCRC.aspx>
- [88] Digidiki V, Bhabha J. Emergency within an emergency: The growing epidemic of sexual abuse and exploitation of migrant children in Greece. 2017. Available from: <https://www.hks.harvard.edu/publications/emergency-within-emergency-growing-epidemic-sexual-abuse-and-exploitation-migrant#citation>
- [89] Pollak S. Violence and Disease in Overcrowded Greek Camp for Migrants. The Irish Times; 2019. Available from: <https://www.irishtimes.com/news/world/europe/violence-and-disease-in-overcrowded-greek-camp-for-migrants-1.3631271>
- [90] Hammond R. Refugees Further Traumatized by Conditions in Greece's Moria Camp: Medecins Sans Frontieres. 2018. Available from: <https://www.doctorswithoutborders.org/what-we-do/news-stories/story/refugees-further-traumatized-conditions-greeces-moria-camp>
- [91] Saleem A. Greece Struggles with New Migrant Influx—An Overview: Infomigrants; 2019. Available from: <https://www.infomigrants.net/en/post/20068/greece-struggles-with-new-migrant-influx-an-overview>
- [92] Nye C. Children 'Attempting Suicide' at Greek Refugee Camp: BBC News. 2018. Available from: <https://www.bbc.com/news/world-europe-45271194>
- [93] Brunovskis A, Surtees R. Identifying trafficked migrants and refugees along the Balkan route. Exploring the boundaries of exploitation, vulnerability and risk. *Crime, Law and Social Change*. 2019;72(1):73-86
- [94] Human Trafficking. Available from: <https://www.unhcr.org/en-us/unhcr-human-trafficking.html>
- [95] NCHHSTP Social Determinants of Health. Centers for Disease Control and Prevention. Available from: <https://www.cdc.gov/nchhstp/socialdeterminants/faq.html>
- [96] Fleischman Y, Willen SS, Davidovitch N, Mor Z. Migration as a social determinant of health for irregular migrants: Israel as a case study. *Social Science & Medicine*. 2015;147:89-97
- [97] Zimmerman C, Kiss L, Hossain M. Migration and health: A framework for 21st century policy-making. *PLoS Medicine*. 2011;8(5):e1001034
- [98] Castenada H, Homes SM, Madrigal DS, Young ME, Beyeler N, Quesada J. Immigration as a social

determinant of health. *Annual Review of Public Health*. 2015;**18**:375-392

[99] Mercy Corps. The World's 5 Biggest Refugee Crises. Available from: <https://www.mercycorps.org/articles/worlds-5-biggest-refugee-crises>

A Moral Perspective on Refugee Healthcare

Tanaya Sparkle and Debanshu Roy

Abstract

There is currently an increasing number of international refugees due to political warfare and natural calamities. Over the recent years, countries are shying away from assisting with the provision of healthcare to this vulnerable population either in their home country through humanitarian aid and services or in the host country by providing free healthcare coverage. World leaders and politicians have attempted to ignore the morality behind these decisions and have put forth a false narrative of scarcity and racism to appeal to the population of developed countries. As this question remains unsolved, we have attempted to look at the question from the perspective of our moral obligations as a species. We have discussed some of the popular moral theories that support providing healthcare services to global refugees and refuted theories that object to the same. We conclude with a brief look at the direction that countries could take without violating established moral code while attempting (without evidence) to prioritize the welfare of their citizens.

Keywords: UNHCR, refugee healthcare, moral theories, lifeboat ethics

1. Introduction

Migration is not going away. A fight for survival and a spirit of curiosity are well-established tendencies of our species. It is hard to put a historical timestamp on when human beings, as we know them, started migrating from their place of birth and settlement to other areas. Some did it in search of better opportunities while others were forced to migrate due to issues such as natural calamities, personal threats, and political warfare. These numbers have only increased with an increase in the world population, climate pattern changes, and individual countries becoming hostile to their own community.

It is no surprise that refugees experience social inequality during their many interactions during displacement and will most likely experience deterioration of their physical, psychological, and social well-being. Poverty and social isolation have adverse health effects in transit and the destination country. The refugees primarily rely on the host community facilities for accessible, acceptable, and reliable healthcare services. While these healthcare services may be partially covered by government health systems and insufficient health insurance, lack of information and language barriers [1] pose significant obstacles to accessing these services effectively. These are particularly significant for undocumented migrants who are often denied access to services for public health or unwilling to use services available to them because of fear of deportation. It is well documented that even migrants with legal rights to healthcare will face numerous obstacles to their use [2]. A systematic

review noted that women with refugee status fared worse with respect to perinatal measures, including mental health, offspring mortality, and preterm birth, compared to women from other migrant groups [1]. The global community faces a crisis, unlike any before. While improved transportation and connectivity have enabled migration and awareness, the steep increase in the number of refugees has led to a lack of consensus when it comes to the matter of refugees and human rights.

One of the primary challenges legislators and healthcare providers face when it comes to providing health security to refugees is a popular ideology that the host country has no responsibility, implying moral and legal, toward providing adequate and safe healthcare to the refugee population due to the argument that responsibility toward its own citizens takes precedence. Support for this argument has been established by the growing number of leaders who have been recently voted for based on their closed border policies [3]. In the light of mounting healthcare costs and challenges related to the provision of healthcare for their population, it is imperative to examine the moral and ethical philosophies proposed toward and against providing health security to the vulnerable world refugee population.

The question of morality here, however, is a complex one due to the contribution of human conscience and sympathy, both of which are subjective and harder to invoke during times of scarcity. Morality also has a temporal, cultural, legal, social, and racial contribution, which makes it harder to examine objectively [4]. Considering this growing human rights crisis, the moral question of the responsibilities of other countries toward resettling and ensuring health security for refugees is an existential one for our species.

2. Methodology

The authors have attempted to synthesize an opinionated albeit comprehensive narrative review on the topic. A broad perspective has been presented including various theories of morality that support the provision of basic healthcare to refugees around the world along with some of the major alternate arguments. Search terms and subject headings were identified for databases including MEDLINE, Google Scholar, and Pubmed. Relevant articles and book chapters were selected. The search used keywords “refugee,” “ethics,” “healthcare,” “morality,” “asylum,” and “aid.” Majority of the articles were obtained using some variation of search string (*ethic* OR morality OR principle**) AND (*refugee* OR asylum**) AND (*healthcare OR aid OR service*). Reference lists of review articles were also searched for any contributory publications. No restrictions were placed on region of origin of publication or on the type of article due to the epistemological nature of the chapter. A google search was also done with the same keywords for news and public opinion articles that were not included in the previously mentioned scientific databases.

3. Historical background

After World War I (1914–1918), millions of people fled for their life. Governments of stable countries were forced to respond by assembling and agreeing to guidelines regarding the provision of travel documents for these people. These numbers increased significantly after World War II (1939–1945), as many more were forced to move and settle elsewhere. The United Nations High Commissioner for Refugees (UNHCR) was founded after World War II on December 3, 1949, due to the increasing number of displaced people [5].

The primary goal was to monitor and protect the human rights of the refugees and displaced people. As the numbers continued to increase, global communities were unsure about the appropriate response.

One of the primary goals of the UNHCR was “To provide international protection to refugees and to seek durable solutions for refugees by assisting Governments in facilitating the voluntary repatriation of refugees, or their integration within new national communities” [5].

According to UNHCR, a refugee is someone who has been forced to flee his or her country because of persecution, war, or violence. They do not have much to lose and a lot to gain by securing entry into a country that, despite the legal uncertainties, is safer than their home country. Two-thirds of all refugees worldwide currently come from just five countries: Syria, Afghanistan, South Sudan, Myanmar, and Somalia. Although two-thirds of the world's refugees come from Syria due to the civil war, the rest are fleeing from other conflicts such as ethnic violence in Myanmar, religious persecution against Muslims in South Sudan, and political warfare in Afghanistan.

According to the 2019 World Health Assembly Update, between 2000 and 2017, the number of international migrants has risen by 49%, a staggering 258 million people. They also noted that most of the refugees are hosted in low- and middle-income countries contrasting the picture painted by political figures. It is valuable to note that the number of internally displaced people has been higher than the number of refugees and asylum seekers confirming that, in most cases, people try to find a safe space within their country due to similarities in culture, religion, language, and food. Estimates by the United Nations Department of Economic and Social Affairs suggest that over 90 million refugees live in the European area of the WHO, accounting for nearly 10%, and nearly one-fifth of the world's population. According to the estimates of the UNHCR, about 5.2 million refugees and 1.4 million asylum seekers live in the region (including refugees) [6]. In short, the numbers are staggering and only rising by the day.

4. Existing laws and guidelines

An examination of ethics is incomplete without a look at current legal provisions. The existing moral code of the people dramatically influences the laws and policies of the state. The United Nations 1951 convention and 1967 protocol had positive outcomes, with 148 countries attending and agreeing to the framework that was laid out. The global policy structure with ramifications for international health security has been recently defined by the World Health Assembly Resolution (2008), the Executive Committee (2007) and the Guiding Principles on Migrants and Refugees Health (2007), and Resolution 70.15 of the World Health Assembly on 2017 on Refugee and Migrants Health.

Other relevant frameworks and resolutions from the past include [7, 8]:

- The 1951 Convention relating to the status of refugees (ratified by 50 of 53 member states) and the 1967 Protocol relating to the status of refugees. The 1951 convention was initially limited to the people fleeing before January 1, 1951 and within Europe, because of World War II. These limitations were removed in the 1967 protocol, making it more universal.
- The 1990 International Convention on the Protection of the Rights of all Migrant Workers and Members of their Families.

- The 2000 Protocol to Prevent, Suppress and Punish Trafficking in Persons, especially Women And Children (ratified by 52 of the 53 Member States).
- The 2000 Protocol against the Smuggling of Migrants by Land, Sea, and Air (ratified by 48 of the 53 Member States).
- World Health Assembly resolution 62.14 on reducing health inequities through action on the social determinants of health and
- WHO Regional Committee for Europe resolution EUR/RC52/R7 on poverty and health, and related follow-ups, such as efforts to address health inequity linked to migration and ethnicity.

5. Current situation and global trend

Changes in governments over time and change in the attitudes of people have made it hard to ensure enforcement of the international laws and guidelines on the provision of healthcare to refugees. Some of the countries such as Germany and Canada welcomed several refugees and provided asylum to them, while others such as the United States and Austria have taken a more rigid stance against them and have implemented legal and physical barriers against asylum seekers. These governments were elected based on their border policies, and therefore, the decisions are not those of individual people alone but a collective majority. This general trend based on a narrative of fear, racism, and scarcity is, unfortunately, proving to be an excellent political strategy. Chancellor of Germany, Angela Merkel, who strongly supported an open border for refugees making Germany one of the most refugee-friendly countries in Europe, had a decrease in popularity shortly after the most significant intake of refugees. News articles reported that her decisions were not well received in the country.

Similarly, Donald J. Trump, president of the United States of America who won in 2016, has a strong anti-immigrant and closed border policy, which continues to be popular with many people in the United States. These recent global trends have made it harder to enforce policies to ensure health security for refugees. The British voted, by a significant majority, to leave the European Union for similar reasons. They cited “unacceptable strains on housing, welfare, and education” as one of the prime reasons for this decision [9–11].

Governments supporting closed borders and fueling racism have led to increase in the backlash against immigrants or ethnically different groups. Right wing support correlated with hate crimes in Germany according to a survey analysis. Similarly, hate crimes in India had surged by 300% which correlated significantly with the election of the right wing Hindu Nationalistic Party, “BJP” [12]. These changes are concerning as it not only endangers the new vulnerable influx population but also affects the integrated existing immigrants and their future generations. Far right policy changes could leave all refugees, immigrants, and even resident nonimmigrants without basic healthcare.

6. Theories of morality

Moral theories attempt to determine right and wrong conduct. They allow individuals and, in extension, countries to critically evaluate the decisions they make in terms of impact beyond the social and economic implications. Morality has allowed the human species to survive in mutual harmony and to promote maximum welfare.

There are many moral theories. Some of the well-studied ones are utilitarianism, Rawls theory of Justice, Kantianism, virtue theory, four principles approach, and casuistry [13].

6.1 Utilitarianism

Utilitarianism holds that morality must aim to maximize human welfare and happiness as a species. John Stuart Mill, a utilitarian philosopher, claimed that actions are right in the proportion they tend to promote happiness and vice versa, where happiness is intended pleasure and absence of pain.

This moral theory supports many actions in medicine, such as triage and social medicine. However, it fails to take into account the age of the person or our obligations toward specific people such as our children or parents. Another reason why this theory is hard to uphold is the degree of self-sacrifice it demands. It obliges us to sacrifice our interests and the interests of the people close to us for the sake of people that we do not know if that is what will maximize good or utility. For example, it is hard to convince a physician in a developed world to move to a developing country while leaving or endangering their family for “utility.” It is also hard to convince a physician in a developing country to avoid pursuing opportunities in developed countries. If going by utilitarian analysis for providing healthcare for refugees, the sheer number of refugees justifies spending resources to provide healthcare to this vulnerable population. In other words, the burden of cost is not high when compared to the suffering of the large number of refugees [4, 13, 14].

6.2 Rawls theory of justice

Rawls’ Theory of Justice [15, 16] is unique in that it considers the moral, cultural, and experiential differences among us that account for our current value system. Understanding that social systems distort our views and bias our opinions of morality one way or the other, Rawls suggests that in order to construct a system or solution for a problem, it must be done objectively. He suggested that a solution must be made after assuming that one has full control and that once implemented, they would be placed back in the society with random features such as sex, race, socio-economic status, or prior experiences of oppression or wealth. For example, in many countries around the world, students from a university in the United States that is not very competitive are given higher status than a student from one of the top-tier Pakistani universities. Although one might argue that the educational system in the United States third-tier university might be better than the education at a top-tier university from a developing nation, this is also not true as evidenced by standard test scores. If used to make a decision about admission criteria, Rawls’ theory might work out the best possible moral solution to the question. Considering these ambiguities, Rawls holds that an objective stance called “The Original Position” (OP) might be the best way to ensure that lawmakers and politicians, who are responsible for all those who are residing in that area, make decisions that are not influenced by their biases. The OP is meant to be impartial while logically striving to aim for systems that have a high probability of supporting progress and decreasing distress in society. The assumption that the policymaker will have no control over their features when placed back in the system hopes to negate some of the biases while making system decisions that impact many people. The privilege walk activity [17] famously demonstrated how the less privileged must work twice as hard as the privileged. Rawls’ concepts also show how dominant systems, countries and organizations, construct systems that ensure their dominance. Rawls believes that social stability can only be achieved by elevating everyone to equal moral worth. Although

he supported distributing resources from the wealthy to the poor, he also stated that opportunities should be based on just innate qualities and a motivation to excel.

Rawls' Law of Peoples adds to the Theory of Justice to provide insight into global ethics and a definition of justice without directly addressing immigration. He relaxed his assumption of society as a closed system or nation-state. He suggested that a decent liberal regime must be enjoyed by all people and expanded on principles of noninterference, respect for human rights, and assistance for countries lacking the conditions for a just regime to arise.

Criticism of Rawls mainly involves practical aspects of implementing a true OP. Also, strict equality principles are rarely favored in the world as there is no easy way of distinguishing between the passive, the corrupt, and the underprivileged. Either way, this has been looked upon as an excellent moral guideline when it comes to making decisions about international health policies and global refugee health security.

6.3 Moral subjectivism

Moral subjectivism [4] holds that right and wrong are determined by the subject and that there are no objective moral properties. All ethical judgments, according to moral subjectivism, are not absolute truths but an attitude or opinion of the subject. In contrast, moral realism states that ethical principles are independent of the personal attitude. A subjectivist, by reasoning, cannot object to anyone's behavior as all behaviors have been approved by the subject in question.

A few objections have been raised about the theory. A subjectivist making a statement about an ethical issue is only communicating a belief and not facts, although the statement might be confusing. For example, when stated by a moral subjectivist, "He is a liar" cannot be an objective statement announcing what one considers an immoral act but can only be a subjective opinion.

There are different types of moral subjectivism:

1. *Simple subjectivism*. The view that all ethical thoughts are not objective truths but personal feelings and attitudes.
2. *Individualist subjectivism*. Protagoras suggested that every human had a distinct moral compass and that his self interest is the goal.
3. *Moral relativism*. Relativism is an extension of moral subjectivism to the society. This view holds that in order to be right, it needs to be approved by the society as well.
4. *Ideal observer theory*. This idea was introduced to account for the biases and irrational ideas in the minds of the people. A hypothetical ideal observer would make the decisions, if there were too many clashes [18].

6.4 Theistic morality

This theory pertains to the belief that morality is linked to religious prescriptions. A person subscribing to theistic voluntarism hold that our morality is governed by "moral obligations" as designed by God. The belief is that God's command and/or God's will (what he desires for us) are the backbone of our moral obligations [12]. Religious philosophers believe that all human beings have been created by God in his image. God's commands are a guide toward fulfilling God's will. Actions are morally required, morally wrong, or morally optional according to this theory. Christian

Miller simplified the theory by delving into scope (Who is expected to live up to a specific desire of God?), objectivity (the inherent morality of certain acts due to the creation of morality by an all-loving knowledgeable being), learning (from religious texts, leaders, revelations, reasoning), and nontheist morality (atheists are also created in the image of God and therefore with a properly functioning reasoning can grasp some of the reasons that inform God's desires related to moral obligations). This theory has been refuted both by debating the presence of a supreme being as well as arguments for "moral constructivism" and "independent moral realism" [12].

Irrespective of the religion, an obligation toward caring for the sick and helpless is prescribed as a moral obligation by the religious texts of major world religions including Judaism, Christianity, Hinduism, and Islam. In extension, healthcare policies that do not include refugees or a subset of refugees violate the code of theistic morality.

6.5 Kantian ethics

Kantian ethics [19] proposes that the morality of an act is decided by the intended consequence of the particular action. Kant said that the "maxim" or intended reason behind our action is vital for determining its rightness. For example, according to this theory, physicians are expected to prescribe what they believe to be the best course of treatment for the patient. A negative outcome due to the prescription would not be considered morally wrong. Whereas, if another physician prescribed a drug to maximize his income, the act of prescribing the drug becomes morally wrong. Kant holds that only goodwill can be morally right.

One of the criticisms is that a country's political system would have a responsibility of individual goodwill under Kantian morality, and this moral obligation would trump a question of utility. For example, according to Kantian morality, impeding the provision of healthcare to refugees would be morally wrong just by the nature of the act and its consequences on the people that the act is intended toward. It would ignore any potential negative consequences on the country's citizens and legal residents. Kant also fails to propose a hierarchy of moral obligations. For example, can one risk the death of a refugee to prevent the death of a legal resident? Can one lie to prevent the murder of their family? Although Kant proposes a moral principle, he also fails to successfully define a strong logical reason to follow his principles.

6.6. Four principle theory of morality

Justice, autonomy, beneficence, and non-maleficence provide another framework for critically evaluating the morality of decisions in Medicine. Justice implies that healthcare resources must be distributed in a fair and just manner. Autonomy allows for individual decisions regarding healthcare. Beneficence is the moral obligation that healthcare workers have to act in order to benefit the patient. Non-maleficence aims to avoid harming patients. This framework, although simplistic, is not all-encompassing, and critical large-scale decisions need to be evaluated using other moral standards.

6.7 Arguments against providing healthcare to refugees

Currently, there is no consensus regarding the matter of refugees, and in extension, the provision of healthcare services for this population. While some countries have upheld the laws that were established to protect their human rights, others

have stayed passive or voiced their lack of support. Many politicians and philosophers have argued against the provision of healthcare services, aid, food supplies, or refuge in case of war, famine, or other international crises. Some of the major claims are listed below along with a look into the validity and significance of the claim.

6.7.1 Limited resources claim

One of the most common arguments put forth against providing aid and services to refugees is the proposition that that resources are limited and that wealthy countries have limited capacity when it comes to resources and capacity. The 2016 British referendum shed light on the costs imposed by refugees and migrants [20]. Garrett Hardin, an American philosopher, has elaborated on this argument in his controversial article, “Lifeboat Ethics: The Case Against Helping the Poor” [21].

He compares a developed nation to a lifeboat. He creates a metaphor by assuming that a developed nation is a lifeboat with a capacity for 60 people with it currently holding 50 with room for 10 more. He then asks the readers to imagine that if the people in the lifeboat saw 100 swimming outside begging for admission, the options that the people inside have are limited.

- Admitting all of them, which would ultimately swamp the boat and drown it.
- Admitting 10 people, which poses further questions such as which ones to deny admission, or if it is a smart decision to load the boat to capacity in the first place.

He states that although it seems “morally abhorrent to many people,” not admitting more people to the lifeboat might be the only way to ensure the survival of the people in the lifeboat by preventing resource shortages and allowing for a safety margin of 10 people” for growth. He supports his argument with the potential effects on the food supplies, fishing supply, and environmental destruction that a few additional millions would have on a “wealthy nation.” He strongly supports a closed border and unflinchingly argues that a developed nation must focus on the protection, welfare, and survival of its own people and that considering the earth’s dwindling resources, the “lucky” nations need to protect what they have instead of giving it away by accepting refugees from other countries.

As to the matter of providing aid and services to war-torn and impoverished nations, Hardin argued that death is a mechanism to prevent overpopulation from destroying the limited resources on earth, which relieves another human being of the moral duty to actively prevent this. In his subsection on “Population Control the Crude Way,” he stated that if other nations did not assist these countries, the rate of population growth in the world would be checked by famine and death. Hardin and other philosophers have suggested that saving refugee lives, by provision of humanitarian aid, poses a potential risk to the chance of survival of human beings due to the limited resources that the earth has.

Most philosophers and world leaders who support the above view are unhappy about the economic costs of providing healthcare and other resources to protect the human rights of refugees due to the costs falling on a few affluent nations. The commitment of the United States to provide \$419 million in humanitarian aid to assist Syrian refugees and the countries holding them was not well received by these philosophers and was used as an argument against the whole approach. They used the standard argument against socialism to argue that nations would be enabled to

draw from aid and to multiply in number instead of attempting to find solutions themselves, eventually bringing ruin upon the world.

The American President Donald Trump, along with other nationalist leaders around the world, believes that refugee presence is costly, dangerous, burdensome, and a drain on the country's resources and has based his political campaign on this policy [22]. Greg Ip [23] stated that people were apprehensive about refugees and immigrants, in general, more due to the value they place on cultural identity than the economy. It is evident that leaders who believe in discouraging refugees from coming into their countries resonate with many people, as evidenced by the overall support separatist leaders have received in recent political times. The return of support for nationalism among the people of developed nations and their pushback against providing refuge for individuals whose governments or people are violating their human rights increases the importance of assessing the ethics behind providing healthcare security to refugees. Although most leaders, if pressed, would agree that fundamental human rights are a requirement for the existence of the human society and species, which must transcend geographic and cultural barriers, their policies say otherwise.

There are many problems with Hardin's comparison of developed nations to lifeboats. Hardin's definition of capacity is far from the real-world capacity of most developed nations and often appeals to a scarcity mentality harbored by many politicians either as a political strategy or as a false personal belief.

Overpopulation seems to be what Hardin is concerned about in the "Lifeboat." Anne Roback Morse and Steven M Mosher defined overpopulation "as a situation where the *number of people* exhausts the resources in a *closed environment* such that it can no longer support that population" [24]. Research has shown that many developed countries are still capable of hosting many refugees before coming remotely close to their "full capacity." Forty-eight percent of people around the world live in countries that have below-replacement fertility rates. Therefore, the initial assumption of Hardin seems to be false even before the presentation of moral arguments [24].

Assuming the assumption of scarcity was true for most countries of the world, Morse and Mosher compared this situation to an office that had too many people. They suggested that, if the environment was closed, resources like water and food would be used up. However, they refuted that most environments are not closed, which is why none of the countries have launched sterilization campaigns or started killing older people, both of which would be morally wrong.

They also extended the argument by comparing the same office to an artificially closed environment, such as a country where governments prevented food and healthcare from being sent to or prevented people from leaving. The burden of morality is not on the "overpopulation of the closed environment" but the tyrannical governments locking people in without providing them with resources when they are available in abundance elsewhere.

Currently, according to research, there is food being produced for more people than people in the world. Resources like food and water are not limited. By large, matter and energy have remained relatively constant. However, they have been mismanaged and contaminated. Scientists have highlighted that currently, every human being could have 5 acres of land and half an acre of arable land. We have survived despite the bleak predictions of the past. Human beings have put their minds together to find solutions for the growing needs and dwindling resources.

By extrapolation, hunger is not a phenomenon due to low supply, but due to political failures and human flaws. Human beings have defied all predictions of doomsday using their minds and technology. There is no absolute reason to believe that they will not continue to do so.

6.7.2 Negative consequences argument

Another argument against providing aid and healthcare services to the countries is a question about the consequence of helping countries in crisis. Hardin states that helping these countries and their governments that do not plan ahead and save for a rainy day, and bailing the population of these challenged countries with aid each time will only allow them to “continue their ways” without planning for a more permanent solution. Considering the higher reproductive rate of underdeveloped countries in crisis, it further contributes toward overpopulation. Hardin believes that the overall stamp of “charity” that most measures to uplift underprivileged communities have harbors a sense of inequality that defeats the whole purpose of integration. The other “negative” consequence and concern of allowing refugees and allowing access to the public health system is the potential increase in illegal immigrants seeking to take advantage of the system. In contrast, there is sufficient evidence that when appropriately integrated, migrants contribute to the economic development of the host country. As per the 2003 stats, 29.4% physicians and 43.5% of nurses in the British National Health service were migrants [25]. According to the analysis of the government expenditure data from 2004 edition of Public Expenditure Statistical Analyses and the public finances section of the Financial Statement and Budget Report, Sriskandarajah et al. reported that the relative net contribution of immigrants was higher than that of the United Kingdom born. They used the ratio of immigrants’ contributions to their consumption of public expenditure, which represented the net annual fiscal contribution (NAFI). The NAFI of migrants has remained higher than that of the UK born since 1999, with a steady relative increase in the contribution from migrants. The NAFI was calculated after apportioning the cost of administering the asylum system to the immigrants alone. To summarize, the migrant NAFI/UK-born NAFI has increased from 1.03 to 1.09 even if the growing asylum costs were divided and included in the immigrant expenditure for calculation [25].

There is little evidence that healthcare is a driver for migration. The major “push factors” noted include conflict in home country and desire for economic progress [26, 27]. Resident migrants and refugees often contribute to the delivery of healthcare and contribute to economic growth of the host country [28].

6.7.3 Competing needs claim

There is a reluctance of most governments to provide refugees with the same healthcare services extended to their citizens. This is due to a concern that by doing so, the vulnerable populations (citizens) of the country might be negatively impacted. Although most policy makers agree upon the universal morality of providing equitable healthcare to all populations, this is sidelined in the name of an already overburdened healthcare system and the potential to encourage illegal immigration by provision of welfare services to all [29]. “Health-related deservingness” [30] has therefore been used to justify excluding refugees and asylum seekers from public healthcare systems. This deservingness has been defined individually by each country based on race, religion, national belonging, and perceived contribution to the society and used to discriminate against refugees. Further studies highlighting the contribution of these immigrants economically and socially might help to attend to the misconception that forms the main basis of this argument.

Besides the strain on the healthcare services, there is a concern that for one group to benefit, the other has to lose out [31]. Due to the motivation of “national economic interest” and the current citizens of the country, policies favoring

equitable healthcare access for refugees and asylum seekers are rejected. There is sufficient evidence from multiple countries around the world showing the economic benefits of migrant influx. It has also been shown that restricting the access of refugees to healthcare could increase the cost more [32, 33].

6.7.4 Cultural and national identity claim

Recently, the importance of national identity and cultural differences as a reason for intolerant attitudes toward refugees has come into light. This has been found to be the primary reason for the support for exclusionary healthcare policies by the host population [34]. A deeper look into this claim is essential considering its growing importance in the political climate of today's developed world.

Refugees from sociocentric cultures find it harder to integrate as compared to egocentric individualistic cultures [35, 36]. Higher social barriers and limited opportunities for new refugees also leads to a higher probability of turning to "their own kind" and forming diaspora communities [37]. This leads to a heightened awareness of their own cultural identity and encouragement of parochial altruism (and potentially outgroup hostility) [38]. All of these factors have been shown to lead to a social distrust, thereby indicating that for a country with a large immigrant population or a country open to welcoming refugees, multiculturalism, albeit controversially, is not the best situation. Unfortunately, mistrust and social exclusion of refugees leads to "collectivistic communities" and "looking inward," which only worsens the problem of social exclusion. In sufficient numbers and in smaller countries, these communities might pose a greater threat to cultural and national identity than if they were welcomed and allowed to integrate successfully with the host country.

Sniderman et al. showed that national identity trumped economic considerations as a reason for opposition to immigrant minorities in western Europe [39]. Tsukamoto and Fiske, across three studies, showed that immigrant groups were thought to be untrustworthy and perceived to threaten American civic values (political ideology, etc.), but not ethnic values (shared cultures, customs, etc.) [40]. The British Social Attitudes Survey indicated that the perceived threat to limited resources, shared traditions of the British society, and, to a lesser extent, the potential for increased crime were the main reasons for an opposition to immigration and, in extension, provision of any services that might encourage immigration [41].

Recent literature has also attempted to tease out some of the factors that lead to a host society fearing loss of national identity and thereby opposing provision of healthcare to refugees, which is thought to encourage immigration. Grajzl et al. proposed and demonstrated that the longevity of national identity had a robustly negative effect on the preference of the host population for cultural assimilation of refugees and immigrants [42]. The modern acculturation theory refers to cultural assimilation as "melting pot" and accommodation of cultural diversity as "multiculturalism." "Ultra-Tolerance" has been described as hypocrisy by some thinkers as in many parts of the world, "tolerance" has started leading to discrimination by the separation of the "tolerant" from the "backward and intolerant" [43].

Irrespective of personal beliefs regarding the claim, the ethics of providing healthcare to refugees is not altered. Fear of loss of cultural identity (religious) might cause psychological distress and hardship to the host population. However, the difference in cost makes it impossible to morally justify the withholding of basic life-preserving and welfare-preserving services to refugees. The question of whether the cost of losing national identity is enough to warrant not permitting refugees to enter is a different one and out of the scope of this discussion.

7. Conclusion

It is easy to understand the moral obligation of helping a man who is bleeding or a woman in labor on the street. The moral obligation is no different when we do not see them directly. Most of the major moral theories, if used to solve the question of providing healthcare coverage to refugees and internationally displaced population, allow us to conclude that in order to be on the right side of morality, it is essential that we do everything we can to provide basic healthcare coverage to all people. Each country does have the liberty to decide what the “minimal acceptable health coverage” needs to be. In the long run, providing healthcare services to all people residing in a country will ensure the welfare of the whole population: citizens, temporary residents, and asylum seekers.

Acknowledgements

Tanaya Sparkle and Debanshu Roy wish to express their special appreciation and thanks to Dr. Thomas Papadimos and Dr. Andrew Casabianca for their encouragement, support, and guidance. Tanaya Sparkle would like to thank Dr. Siddharth Kunte for his help with critical arguments about the topic.

Conflict of interest

The authors declare no conflict of interest.

Author details


Tanaya Sparkle^{1*} and Debanshu Roy²

1 University of Toledo Medical Center, Toledo, OH, United States of America

2 University of Chicago Trusts, Delhi, India

*Address all correspondence to: tanaya.sparkle@utoledo.edu

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Heslehurst N, Brown H, Pemu A, et al. Perinatal health outcomes and care among asylum seekers and refugees: A systematic review of systematic reviews. *BMC Medicine*. 2018;**16** [Epub ahead of print]. DOI: 10.1186/s12916-018-1064-0
- [2] Davies A, Basten A, Frattini C. Migration: A social determinant of migrants' health. *Eurohealth*. 2009;**16**:10-12
- [3] Cunliffe K. Holding the world accountable: A philosophical analysis of the refugee crisis and the moral obligations of the global community. *Political Science*. 2017. Available from: https://scholar.colorado.edu/concern/undergraduate_honors_theses/kw52j852b
- [4] Ozgumus AM, Ekmekci PE. Refugee health: A moral discussion. *Journal of Immigrant and Minority Health*. 2019;**21**:1-3
- [5] UNHCR. Human Rights and Refugees Fact Sheet No.20. Available from: <https://www.ohchr.org/Documents/Publications/FactSheet20en.pdf>
- [6] UNHCR. UNHCR—Global Trends: Forced displacement in 2016. *Glob Trends*. Available from: <https://www.unhcr.org/en-us/statistics/unhcrstats/5943e8a34/global-trends-forced-displacement-2016.html>
- [7] WHO Regional Office for Europe. Regional situation analysis, practices, experiences, lessons learned and ways forward. Available from: <https://www.who.int/migrants/publications/EURO-report.pdf?ua=1>
- [8] Donaldson L, Banatvala N. Health is global: Proposals for a UK government-wide strategy. *Lancet*. 2007;**369**:857-861
- [9] Rietveld E. Debating multiculturalism and national identity in Britain: Competing frames. *Ethnicities*. 2014 [Epub ahead of print]. DOI: 10.1177/1468796813497209
- [10] Kohler-Koch B, Rittberger B. *Debating the Legitimacy of the European Union*. Rowman & Littlefield Publishers; 2007
- [11] Swain CM. *Debating Immigration*. 2007 [Epub ahead of print]. DOI: 10.1017/CBO9780511804830
- [12] Miller CB. Morality is real, objective, and supernatural. *Annals of the New York Academy of Sciences*. 2016 [Epub ahead of print]. DOI: 10.1111/nyas.13074
- [13] Khalil S. Ethics beyond borders: The nature of our responsibility towards the refugee population
- [14] Grove NJ, Zwi AB. Our health and theirs: Forced migration, othering, and public health. *Social Science & Medicine*. 2006;**62**:1931-1942
- [15] Rawls J. Justice as fairness: Political not metaphysical. In: *Equality and Liberty*. 1991 [Epub ahead of print]. DOI: 10.1007/978-1-349-21763-2_10
- [16] Rawls J. A theory of justice. In: *Essays and Reviews: 1959-2002*. 2014 [Epub ahead of print]. DOI: 10.5840/tpm20136171
- [17] Samuels DR, Ferber AL, Herrera AO. Introducing the concepts of oppression & privilege into the classroom. *Race, Gender & Class* [Epub ahead of print]. 2003. DOI: 10.2307/41675098
- [18] Firth R. Ethical absolutism and the ideal observer. *Philosophy and Phenomenological Research*. 1952. DOI: 10.2307/2103988
- [19] Korsgaard CM. Kant's formula of universal law. *Pacific Philosophical*

- Quarterly. 1985 [Epub ahead of print]. DOI: 10.1111/j.1468-0114.1985.tb00240.x
- [20] Dorling D. Brexit: The decision of a divided country. *British Medical Journal*. 2016 [Online] [Epub ahead of print]. DOI: 10.1136/bmj.i3697
- [21] Hardin G. Lifeboat Ethics: The Case Against Helping the Poor. *Psychology Today*. September 1974:38
- [22] Amuedo-Dorantes C, Puttitanun T, Martinez-Donate AP. Deporting “Bad Hombres”? The profile of deportees under widespread versus prioritized enforcement. *International Migration Review*. 2019 [Epub ahead of print]. DOI: 10.1177/0197918318764901
- [23] Ip G. A fractured world: Nationalism vs. the global liberal order. 2018. Available from: <https://www.wsj.com/articles/a-fractured-world-nationalism-vs-the-global-liberal-order-1516655705>
- [24] Morse A, Mosher S. Debunking-the-myth-of-overpopulation. 2013. Available from: <https://catholicexchange.com/debunking-the-myth-of-overpopulation>
- [25] Sriskandarajah D, Cooley L, Reed H. Paying their way the fiscal contribution of immigrants in the UK. 2005. Available from: www.ippr.org [Accessed: 02 March 2020]
- [26] International Organization for Migration. *World Migration Report 2013. Migrant Well-Being and Development*. 2013 [Epub ahead of print]. ISBN: 9789290686682/ISSN 15615502
- [27] Pedersen PJ, Pytlikova M, Smith N. Selection and network effects- Migration flows into OECD countries 1990-2000. *European Economic Review*. 2008 [Epub ahead of print]. DOI: 10.1016/j.euroecorev.2007.12.002
- [28] Simpson JM, Esmail A, Kalra VS, et al. Writing migrants back into NHS history: Addressing a ‘collective amnesia’ and its policy implications. *Journal of the Royal Society of Medicine*. 2010 [Epub ahead of print]. DOI: 10.1258/jrsm.2010.100222
- [29] Hall MA, Perrin J. Irregular migrant access to care: Mapping public policy rationales. *Public Health Ethics*. 2015 [Epub ahead of print]. DOI: 10.1093/phe/phv016
- [30] Gottlieb N, Ben MY. Discussing rights and wrongs: Three suggestions for moving forward with the migrant health rights debate. *Bioethics*. 2018;**32**(6):353-359. DOI: 10.1111/bioe.12460
- [31] Dustmann C, Preston IP. Racial and economic factors in attitudes to immigration. *B.E. Journal of Economic Analysis & Policy*. 2007 [Epub ahead of print]. DOI: 10.2202/1935-1682.1655
- [32] Bozorgmehr K, Razum O. Effect of restricting access to health care on health expenditures among asylum-seekers and refugees: A quasi-experimental study in Germany, 1994-2013. *PLoS One*. 2015;**10** [Epub ahead of print]. DOI: 10.1371/journal.pone.0131483
- [33] FRA (European Union Agency for Fundamental Rights). *Cost of Exclusion from Healthcare. The Case of Migrants in an Irregular Situation*. 2015 [Epub ahead of print]. DOI: 10.2811/825284
- [34] Prinz A. Migration, cultural identity and diasporas an identity economics approach. *IZA Journal of Development and Migration*. 2019;**10** [Epub ahead of print]. DOI: 10.2478/izajodm-2019-0001
- [35] Bourque F, Van Der Ven E, Malla A. A meta-analysis of the risk for psychotic disorders among first- and second-generation immigrants. *Psychological Medicine*. 2011 [Epub ahead of print]. DOI: 10.1017/S0033291710001406

[36] Bhugra D, Becker M. Migration, cultural bereavement and cultural identity. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*. 2005;4:18-24

[37] Schelling TC. Dynamic models of segregation. *Journal of Mathematical Sociology*. 1971 [Epub ahead of print]. DOI: 10.1080/0022250X.1971.9989794

[38] Gelfand M, Shteynberg G, Lee T, et al. The cultural contagion of conflict. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 2012 [Epub ahead of print]. DOI: 10.1098/rstb.2011.0304

[39] Sniderman PM, Hagendoorn L, Prior M. Predisposing factors and situational triggers: Exclusionary reactions to immigrant minorities. *American Political Science Review*. 2004 [Epub ahead of print]. DOI: 10.1017/S000305540400098X

[40] Tsukamoto S, Fiske ST. Perceived threat to national values in evaluating stereotyped immigrants. *The Journal of Social Psychology*. 2018 [Epub ahead of print]. DOI: 10.1080/00224545.2017.1317231

[41] McLaren L, Johnson M. Resources, group conflict and symbols: Explaining anti-immigration hostility in Britain. *Political Studies*. 2007 [Epub ahead of print]. DOI: 10.1111/j.1467-9248.2007.00680.x

[42] Grajzl P, Eastwood J, Dimitrova-Grajzl V. Should immigrants culturally assimilate or preserve their own culture? Host-society natives' beliefs and the longevity of national identity. *Social Science Research*. 2018;75:96-116

[43] Wit T. Between indifference and the regimes of truth. An Essay on Fundamentalism. Tolerance and Hypocrisy. *Philosophia*. 2015;44. DOI: 10.1007/s11406-015-9596-4

Strengthening International Health Security by Embedding the Role of Civil Society Organizations in National Health Systems: Lessons from the 2014–2016 West Africa Ebola Response

Martin Hushie, Rita Suhuyini Salifu and Iddrisu Seidu

Abstract

Following the recent global health crises, such as the 2014 Ebola and 2016 ZIKA outbreaks, the international health community's ability to deal with such threats has been debated. Amid discussions of how international health security (IHS) and related national health systems should and could be strengthened, the potential of harnessing the role of civil society organizations (CSOs) for more effective responses has been frequently raised. Such participation is often based on the notion that CSOs by their grassroots presence can more effectively help to address health security and health systems challenges in affected populations and communities. Using the World Health Organization's (WHO) health systems' building blocks as an evaluative framework, this chapter examines CSOs' roles and responsibilities during the 2014–2016 West Africa Ebola Outbreak and how they can be further empowered to perform these functions. The chapter draws conclusions about the opportunities and challenges CSOs represent for strengthening IHS and national health systems during public health emergencies in low- and middle-income countries (LMICs).

Keywords: civil society organizations, health system, international health security, Ebola virus disease, West Africa

1. Introduction

Ebola Virus Disease (EVD) is recognized as one of the most fearful contagious diseases affecting mankind in recent times. The disease was first confirmed in 1976 in Zaire [now the Democratic republic of Congo (DRC)] near the Ebola River [1]. Following this, more than 25 outbreaks have been reported in the DRC, Gabon, Sudan, and Uganda with high mortality rates ranging between 25 and 90% [2, 3].

Towards the end of 2013, the West African Sub-region experienced the first case of the EVD in Guinea [4], which rapidly spread to Liberia and Sierra Leone with additional cases being reported in Mali, Nigeria and Senegal. This outbreak

was quite significant regarding its unparalleled high morbidity and mortality rates; longevity and size; and how it increasingly became a global public health problem, resulting in the WHO declaring it as Public Health Emergency of International Concern [5]. By March 27, 2016, Sierra Leone reported the highest cases of 14, 124, followed by Liberia (10,675) and Guinea (3811) [6].

It is widely recognized that strong, well-funded and well-staffed health systems are fundamental prerequisites in the fight against diseases such as Ebola. However, the three most affected countries, Guinea, Liberia, and Sierra Leone, had suffered years of devastating civil wars that led to widespread poverty, weak infrastructure and a lack of health professionals, especially in rural areas. Consequently, the Ebola containment efforts were severely hampered by already weak and fragile health systems, including poor surveillance preparedness and weak governance systems [7–9].

Increasingly, a wide range of studies of international health security (IHS) governance and health systems' functioning have drawn attention to significant shortfalls in prevailing institutional arrangements to deal with such pandemics [10–12]. Typically, much of the criticism has fallen on the WHO as the lead organization responsible for global health governance [10, 13, 14]. Problems such as not responding promptly or in an ad hoc fashion; creating panic among affected populations; limited lessons learnt from previous pandemics; bureaucratic and political barriers that constrain the establishment of appropriate communication and organizational systems and structures for responding more effectively-have all been cited [15, 16]. Overall, there is a perception that IHS governance is characterized by dysfunction. As a result, proposals for moving the IHS agenda forward have called for significant reforms, including better resourcing of the WHO to counter future pandemics as well as consolidating the global health community's commitment and knowledge to promote and improve IHS both nationally and internationally [17–19].

Central to these discussions of how IHS and health systems should and could, be strengthened have included considerations to adopt more joined-up approaches that harness the role and strengths of civil society organizations (CSOs) [20, 21]. Such participation is often premised on the assumption that CSOs' grassroots linkages and close proximity to the communities most affected by specific health challenges gives them comparative advantage in providing effective and targeted interventions that reflect local contexts, needs and realities, which add to promoting democratic and accountable governance processes in global health [22]. To date however, how CSOs' engagement enables or constrains the search for effective organizational arrangements in the IHS and health systems strengthening agenda, is not well understood. Greater clarity on CSOs' contribution is needed to guide action.

2. The expanding role of CSOs in IHS and health systems

“Given the growing complexity of these health and security challenges and the response required, these issues concern not only governments, but also international organizations, civil society and the business community. Recognizing this, the World Health Organization is making the world more secure by working in close collaboration with all concerned.”—Margaret Chan, Director General, WHO, World Health Day, 2007.

CSOs have a long history as significant players in global health and development that is well-documented [23–25]. The growing prominence of CSOs, especially in the health systems of low- and middle-income countries (LMICs), is related to the fact that CSOs have increasingly constituted preferred conduits for external

donor funding based on the assumption that CSOs by their small nature, flexibility, empowering activities are more cost-effective and better options for reaching poor and vulnerable populations [26, 27]. This position increasingly used by donors to channel aid to and through CSOs became particularly important following the implementation of structural adjustment policies (SAPs) from the 1980s onwards. As part of the dominant neoliberal agenda to revamp the deteriorating economic conditions that engulfed these countries, SAPs were used to curtail budget deficits by reducing expenditures on social services such as health, housing and education. Moreover, privatization and reduced role of the state were made pre-conditions for financial assistance and debt rescheduling [28–30]. The prevalence of weak governments and declining economies increasingly left NGOs as the only alternative to implement health and development interventions, especially for poor and marginalized people [31–33]. This resulted in a dramatic increase in their number, diversity and the functions they perform in health systems around the globe—a development that is largely seen in positive terms.

Within the context of IHS, CSOs have played significant roles in supporting large-scale epidemics or pandemics such as HINI, Ebola and ZIKA that have constituted substantial threats to human security and public health around the globe [34]. Moreover, CSOs responses and contributions to fighting epidemics including HIV/AIDS, yellow fever, cholera and malaria have been widely acknowledged. Working on the frontline of public health responses, CSOs collaborate with public health authorities and local communities to provide primary health care and critical services, health education and shelter in affected communities that national governments will not or cannot provide for lack of resources [35–37].

Although the value of civil society participation as partners in global health governance processes and mechanisms is almost ubiquitously endorsed, there is paucity of evidence on the role CSOs play in the IHS and health systems strengthening agenda. What roles do CSOs play and are they appropriate? How well are these roles fulfilled? An emerging body of research from the recent Ebola epidemic in West Africa, reveals complex health systems challenges that have the potential to limit the extent of true participation [7–9]. However, little current literature engages empirically with CSOs' roles and the advantages and disadvantages coming along with their engagement. This paper aims to fill this knowledge gap through a synthesis of the evidence from individual studies on the nature of CSOs' involvement in the 2014–2016 Ebola outbreak and their positive and negative effects in strengthening the health systems of the affected countries. The findings contribute to understandings of CSOs' roles and functions when responding to public health threats in low resource settings with weak health systems. They are also significant for understanding how and where interactions between CSOs and the health system can be best leveraged to build more resilient health systems for containing large-scale epidemic outbreaks.

The chapter is organized as follows. First, we provide a review of the terms CSOs, IHS and health systems strengthening and their inter-relatedness to provide a conceptual framework for the study. Second, the methods utilized; and the results and discussions in relation to the contributions and challenges to CSOs' engagement in the EVD response are presented in the subsequent sections. Lastly, based on the findings, conclusions are drawn about how to better embed CSOs' roles in health systems in support of public health emergencies in LMICs.

3. Defining CSOs, IHS and health systems strengthening

Despite CSOs growing prominence, the term and its relationship to IHS and health systems strengthening is under debate. To better understand the CSOs' roles

in these global health governance arrangements, workable definitions of the terms are needed. CSOs have been defined in several ways, however, the WHO views Civil society as “the space for collective action around shared interests, purposes and values, generally distinct from government and commercial for-profit actors” [38]. CSOs include a wide array of organizations: community-based organizations, non-governmental organizations (NGOs), labor unions, indigenous groups, charitable organizations, faith-based organizations, professional associations, and foundations.

IHS or global health security on the other hand, is viewed as those functions concerned with preventing, detecting and responding to infectious disease outbreaks, whether man-made or natural, to limit their socio-economic impact across national and international boundaries [20]. It is rooted in the International Health Regulations (IHR, 2005)—a legal instrument that provides guidance regarding how national governments should develop and maintain country-level systems and structures for containing diseases of public health importance [39]. Over the years, poor conformance of countries to the IHR resulted in an IHS agenda being launched in 2014 as a global partnership comprising over 64 countries, international organizations and NGOs to promote country investments in meeting the IHR's requirements [20].

The WHO defines a health system as all activities whose primary purpose is to promote, restore and maintain health [40]. Acknowledging the health strengthening systems agenda, the WHO also states that “a well-functioning health system working in harmony is built on having trained and motivated health workers, a well-maintained infrastructure, and a reliable supply of medicines and technologies, backed by adequate funding, strong health plans and evidenced based policies” [41]. This framework encapsulates what has become known as the WHO's health systems “building blocks” [42, 43]. These include: (i) service delivery, (ii) health workforce, (iii) health information systems, (iv) medical products, vaccines and technologies (v) health financing, and (vi) leadership/governance (**Figure 1**). Good service delivery entails the provision of services that are safe, cost-effective, of high quality, patient-centered and equitably accessible to all segments of the population that need them, when and where needed [42, 43]. A well-performing health workforce should be appropriately qualified, responsive, efficient and evenly distributed to provide the best possible health outcomes for the entire population within the limits imposed by available resources [42, 43]. Such providers include doctors, nurses, pharmacists and health management staff. A well-functioning health information system ensures the timely collection, analysis, and dissemination of vital information on health determinants, health system performance and health status [42, 43]. An effective health system ensures that essential medical products, vaccines and technologies of high quality, safety, efficacy and cost-effectiveness are equitably accessible and available for meeting the priority needs of the entire population [42, 43]. A good health financing system mobilizes adequate funds for health and ensures that people have access to the services they need without incurring any financial hardship or impoverishment in having to pay for them. Well-funded health systems are needed to support other health systems blocks, such as workforce recruitment, procurement of medical product and implementation of public health programs [42, 43]. A good leadership and governance health system ensures that planned policy frameworks exist, combined with effective oversight and coalition building; regulation and incentives, attention to system design and accountability [42, 43]. Strengthening health system thus means promoting effective interactions between these six health system building blocks to achieve more equitable and sustained improvements in the public's health.

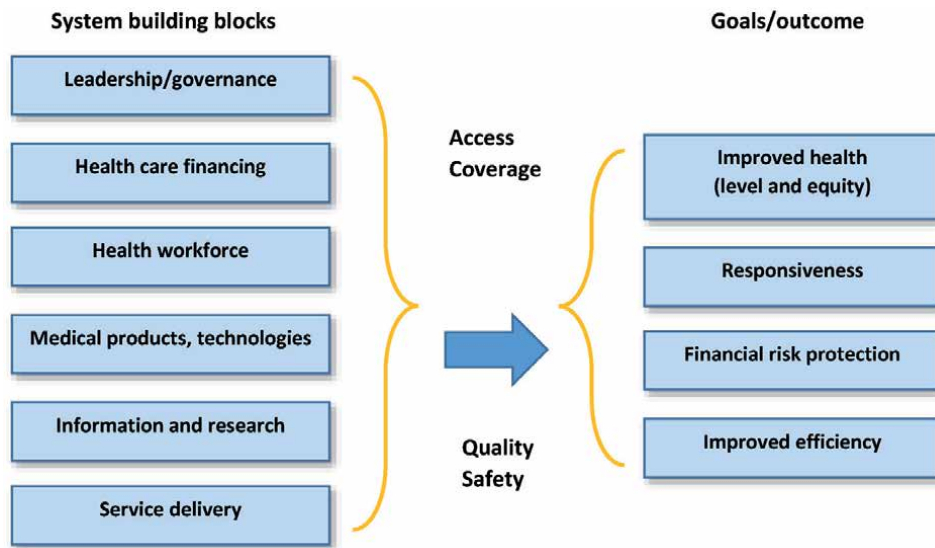


Figure 1.
The WHO health systems' framework.

Originally, the health systems framework was not developed as a research tool, but as a means of promoting investment of resources in health systems [44]. In this study, however, it was selected for its acceptability by the wider international health community as a set of agreed health priorities that can be used to frame an understanding of what a health system is and how it can be strengthened [45]. Moreover, given that health systems are characterized by a diversity of actors, interests, activities and relationships, the framework was found useful for categorizing the unique contribution of CSOs among the range of actors responding to the Ebola pandemic. A recent systematic review of the building blocks' importance for the Ebola Outbreak, as well, highlights their relevance in practice and as an evaluative framework [45].

4. Methods

This chapter draws on academic literature and other publicly available sources, including reports by international or non-governmental organizations to map out the roles played by CSOs during the 2014–2016 West Africa EVD outbreak. The authors reviewed articles published from 2013 to 2019 from electronic databases including, PubMed, Medline via EBSCOhost, Embase, Global Health and Cochrane library as well as relevant articles and Gray literature from Google Scholar, Scopus and relevant Internet websites (WHO, Médecins Sans Frontières (MSF, Doctors Without Borders) and Centers for Disease Control and Prevention (CDC). Search terms (Medical Subject Headings (MeSH) and Keywords such as Civil Society Organization, Non-Governmental Organization, Community-Based Organization, Ebola Virus Disease, West Africa, Health Systems, and Community Participation were used to identify articles.

The review included only studies focusing on CSOs' functions and challenges during the West Africa Ebola outbreak in Guinea, Liberia, and Sierra Leone as well as reports from international organizations such as WHO, CDC and MSF. Articles on Ebola Virus outbreak before 2014/2015 and those outside these three countries were excluded. Data extraction entailed initial screening of titles and abstracts for

eligibility based on the objectives of the study. Subsequently, potentially useful, full copies of the article were retrieved for further screening and inclusion in terms of its setting, aims and design; which aspects of the health systems building blocks being discussed and CSOs' role in this; major findings, limitations and future recommendations.

5. Results and discussion

There is a relatively small but growing volume of literature on the contributions and challenges of CSOs strengthening health systems while responding to the West Africa Ebola outbreak. This section presents findings pertaining to the six health systems building blocks. It cites some of the strongest examples where CSOs' roles can be particularly strengthened and better institutionalized in countries to more effectively respond to future epidemics in relation to: leadership and governance, health information systems, service delivery, medical products, vaccines and technologies, human resources and health financing.

5.1 Leadership and governance

Strong leadership and good governance practices, including multi-scale and cross-sector response are critical in responding to major public health threats such as EVD. It underpins the other health systems components and constitutes the backbone of any effort to secure sustainable, responsive health systems to outbreaks. However, the West Africa outbreak pointed out the lack of effective health governance, in terms of coordination, emergency preparedness and responsiveness (including limited resources-financial, physical and human) in the affected countries, which adversely affected containment efforts and thus requiring urgent assistance from international actors [46].

Of the six the building blocks, this study found the leadership and governance block as the major entry point through which CSOs' distinctive roles become critical in responding to public health threats such as the West Africa EVD outbreak. This was found to be true at both the international and national levels. At the international level, while it is well-recognized that global health governing institutions such as the WHO and UN, bilateral and philanthropic donors were initially slow to respond to the EVD, [46] it is also well documented that NGOs such as MSF, were among the first to warn about the epidemic's unprecedented spread, which ultimately led the WHO to declare it as a 'public health emergency of international concern' on August 8, 2014. By early September, there was still no coordinated international response and again, it was MSF that called for the deployment of military biological teams as 'a last resort, in the hope of bringing about a rapid and concrete action at the field level' [47]. This eventually led to a launch of the global response beginning with the passing of the UN Security Council Resolution 2177.

At the national level NGOs contributed towards the establishment of multi-disciplinary rapid response centers and teams across affected countries, such as the Emergency Operations Centers, National Ebola Response Center in Sierra Leone and Guinean National Ebola Coordination Cell as overarching governance bodies for countering the epidemic. The coordination efforts of these teams and centers were rendered difficult by the large number of partners involved from the international community, each with different priorities, expertise and volume of resources [46]. To address some of these challenges NGOs fell on globally approved approaches and tools to formulate plans and strategies, mobilized their resources, outbreak response experiences and helped to establish

ownership and accountability mechanisms—which are often non-existent in the public sector of LMICs. These efforts thus supported improved stewardship of resources and promoted an effective coordinated cross-sectoral response to the epidemic [47–49].

5.2 Health information systems

One central pillar of the IHR (2005) is for countries to have in place some type of public health surveillance system that has the capacity to detect, verify and track diseases rapidly and to ensure timely data sharing and decision-making among various national and international stakeholders including the WHO [39]. However, the prevailing national-level EVD surveillance systems (comprising of reported cases investigation, telephone hotlines for reporting events, contact tracing, patient screening at health care facilities and swab testing of corpses)—usually based on health facility information in the affected countries—could not rapidly identify infected persons and respond to alerts until they had died [50]. The complex nature of the response required coordinated bottom-up approaches to EVD surveillance (involving local communities, districts and health facilities) to quickly detect and report new cases; and NGOs were the first to champion the establishment of such systems. Thus in Sierra Leone for instance, the International Rescue Mission initiated the creation of the Ebola Response Consortium (ERC) (consisting of a group of 15 NGOs with district-wide presence throughout the country) to supplement the national surveillance system and support the Sierra Leone’s Ministry of Health and Sanitation (MoHS) for responding to the EVD pandemic. The ERC collaborated with the CDC and the MoHS to design and implement the community event-based surveillance system by training pre-existing networks of community health workers to identify unsafe burials and persons showing EVD signs and symptoms. This helped in quickly detecting, insulating, treating and preventing further spread of the disease [51].

5.3 Service delivery

Similar to most countries in sub-Saharan Africa, health care services in the affected countries were characterized by asymmetrical distribution with significant disparities in health equity and access, as well as diminished appeal for services [52]. Collectively, these factors contributed towards the unprecedented spread of the outbreak. As implementing partners in the emergency response, NGOs often adopted operational flexibility by tailoring their activities to address evolving local needs in support of the national response bodies and ministries of health of the affected countries through the provision of a wide range of health services with an ultimate goal of filling existing gaps in the health system.

Depending on the local context and needs, some NGOs focused on refurbishing existing public health care facilities (district hospitals and health centers), while others were engaged in the construction of new EVD treatment units (ETUs) for providing clinical care to patients and to ensure the safety of clinicians providing such care [46, 52, 53]. Apart from supporting with the establishment of ETUs, some NGOs engaged in social mobilization, community empowerment and public education activities to educate community members on how to recognize EVD signs and symptoms and refer potentially infected individuals to the nearest health facility. Significantly, these social mobilization and educational outreach efforts allow CSOs to maintain a continuous and integrated chain of functions that brings together the local communities, health centers and hospitals for more effective service delivery [46].

Moreover, while the international communities' approach to responding to such epidemics most often seek to halt or prevent new transmissions [54], most NGOs adopted a two pronged approach to service delivery in which the prevention of new infections and the improvement of clinical outcomes for infected patients were concurrently prioritized as mutually interdependent objectives in responding to the EVD outbreak [46].

In addition, due to the tendency for Ebola survivors to become susceptible to social, economic, psychological and clinical challenges, including the experience of stigmatization, economic deprivation and other health conditions [54], NGOs supported with the establishment of post-epidemic survivor programs and associations (e.g., Sierra Leone Association of Ebola Survivors) in the affected countries collaborating with ministries of health and other international agencies. Such programs have included the enrollment of survivors in vocational and literacy training, employing survivors to lead community mobilization and empowerment initiatives in Ebola affected communities as well as the provision of critical health care services to diagnose and treat the clinical sequelae of EVD that includes vision impairment, hearing loss, mental health and other physical ailments [55]. By providing these medical and socio-economic responses, NGOs were not only able to treat more Ebola patients and prevented further spread of the virus among family and community members but also helped survivors to revert to normal lives post-epidemic.

5.4 Medical products, vaccines and technologies

Another health system building block related to service delivery, including medical products (vaccines, drugs, medical devices) which are central in delivering an emergency response were lacking in the affected countries and severely hampered containment efforts. In order to fill some of these health system gaps, most CSOs considered developing new vaccines, rapid diagnostic and therapeutic tools to be critically important in fighting the epidemic. Thus, most sought to leverage the expertise and resources of governmental public health agencies, e.g., the CDC, UK's Public Health England and Chinese Center for Disease Control and Prevention that specialize in the development of vaccines and laboratory testing tools. Apart from supporting the development of these tools, local laboratory technicians and other health professionals were trained in their use for diagnosing Ebola [46].

5.5 Human resources

Effective emergency preparedness and responsiveness to public health threats such as EVD requires essential human resources for health in terms of numbers and availability, appropriate training, expertise and motivation, and deployment. However, the three affected West African countries lacked such well-trained and motivated health work force. Consequently, how to recruit, train, protect, and pay a health work force that included government employees, temporary workers, and many international volunteers of various expertise were central concerns in the efforts to contain the epidemic. Working in close collaboration with international actors and the health system CSOs supported the West Africa outbreak with a mix of health workforce including doctors, nurses, laboratory personnel, public health specialists and risk-communication professionals [56].

Additionally, since the success with which public health threats such as EVD can be contained depends on the knowledge, skills and experience of first responders in affected communities [57], many CSOs sought to strengthen the emergency Ebola response by training thousands of clinicians, non-clinicians, nurses and volunteers

in infection, prevention and control measures (IPC). This included triage and disinfection procedures, use of protective clothing, and safe disposal of waste in public hospitals and rural clinics to limit the risk of transmission [56]. Others also provided training to community health workers and community leaders in first aid, public hygiene promotion among the at-risk populations, EVD signs and symptoms identification and provision of psycho-social support and counseling for affected individuals and households. This way CSOs are able to mobilize the requisite local knowledge and skills, trust and bonds of solidarity that helps staff to rapidly detect and effectively respond to Ebola [46].

5.6 Health financing

Lack of adequate funds invested in health system infrastructure such as local laboratory and diagnostic services; disease surveillance, purchase of supplies and training specialist work force were major obstacles in containing the West Africa outbreak. In order to address some of these investment gaps in the health systems of the affected countries, varied funding models were used by CSOs and philanthropic foundations and organizations to support the epidemic. These included: (1) foundations providing direct support to global health governing institutions such as the WHO and UN agencies, (2) international NGOs directly funding national governments, (3) foundations channeling funds through international NGOs, (4) international NGOs disbursing funds directly to local CBO implementing partners, and (5) foundations deploying funds through other foundations to support governmental public health institutions [58].

Funding through these varied mechanisms were deployed to strengthen the health systems of the affected countries while responding to the epidemic in several ways. These included: (a) building ETUs and community health centers for treating victims, (b) constructing and rehabilitating water supply for treatment centers, (c) providing medical equipment and supplies; (d) running mass media public health information campaigns to boost media awareness of preventative measures, (e) providing training and support for community health workers and (f) building the capacity of governmental public health organizations in the development of novel vaccines, diagnostic and therapeutic tools [59].

6. Challenges to CSOs engagement and lessons learnt

CSOs faced significant challenges in the countries affected by Ebola as the epidemic accelerated and valuable lessons were learned in the effort to address those challenges. While some emanated from factors intrinsically linked to the normative structure and functioning of CSOs, others can only be understood within the wider institutional frameworks through which national governments and transnational actors-with varying interests, degrees of power and ways of operating, currently respond to public health emergencies.

First, analyses of CSOs' engagement have identified issues including: (1) failure to take cognisance of the local socio-cultural and political contexts in implementing seemingly technical EVD interventions, (2) poor response coordination among CSOs themselves or with national governments, and (3) the slowness with which CSOs already working in the affected countries shifted from a development approach to an emergency humanitarian method for fighting the epidemic [60]. Related recommendations for more effectively engaging CSOs in public health emergencies of such a scale have included the need for CSOs to: (1) make their technical program activities politically and culturally sensitive to local contexts and needs, (2) support established

national government response coordination structures, rather than setting up parallel structures of their own, and (3) prioritize disease prevention, outbreak spread and saving lives over developmental activities during such health crises [61, 62].

Second, the WHO as the leading organization for global health governance faced significant challenges responding to the epidemic. Among several others, critics have cited politicization of the epidemic that compromised its ability to alert the global community, lack of skilled human resources and financial resources as barriers [60]. Suggested recommendations for enhancing the organization's performance have included the need to revamp its leadership and governance systems, including the establishment of a dedicated unit for outbreak response, supported by a strong technical capacity, budget and clear lines of accountability. Others have also suggested adequate resourcing of the WHO through untied funds for flexible deployment in times of global health crises as well as the need to establish independent and politically-protected Standing Emergency Committees among international and country-level WHO representatives. Such committees—it is argued—can quickly make declarations on infectious diseases of public health importance for the requisite emergency responses to be implemented [62–65].

Third, regarding national governments, weak health governance and management systems within the public health sector, including underdeveloped disease surveillance and alert systems, and other health systems challenges such as lack of financial, human and material resources have all been identified as hampering containment efforts of the epidemic [60]. Recommended changes for improving health governance in the affected countries have included the need for national governments to invest in detection and emergency response capacities within the framework of IHR regulations, assume local ownership in dealing with public health emergencies as well as working collaboratively with international partners to fight future epidemics [62–65].

Fourth, wider issues related to: (1) lack of reliable systems for sharing epidemiological, genomic clinical data and processes for developing accurate or adaptable and diagnostic tests, drugs and vaccine platforms, (2) lack of flexibility in donors' funding mechanisms and contracts and delays in disbursing funds and (3) the mounting of unnecessary trade bans and travel restrictions by outside governments that restricted the flow of humanitarian workers and supplies have been cited as additional constraints that need to be addressed to facilitate CSOs engagement in future public health emergencies [60].

Fifth, primary psychosocial and mental health impacts that are the direct and immediate consequences of the epidemic on human health have been recognized to potentially affect a wide group of people at the individual, community and international levels. At the individual level, such impacts have been attributed to the traumatic course of the infection, fear of death and experience of witnessing others dying, feelings of shame or guilt (e.g., from transmitting infection to others) and stigmatization and/or isolation from their communities. At the community level, a recurring pattern of anxiety ensues, with a loss of trust in health services, stigma and/or isolation, loss of support or coping resources resulting in disruptions of community and cultural life. At the international level, fear and anxiety (e.g., of infection), trauma (e.g., of international aid workers witnessing deaths caused by Ebola), stigmatization of health workers returning from affected countries all together, severely constrained the provision of resources (e.g., health workers and funding) in support of the epidemic. In order to address some of these primary humanitarian problems and impacts, it has been suggested that efforts should engage CSOs and communities, to rebuild health systems and trust and to limit stigma [66, 67].

Finally, beyond these primary psycho-social impacts, the literature also attends to secondary socio-economic impacts, including negative effects that are not caused by the epidemic itself but by its unintended consequences. Such secondary impacts, which can span a longer period than the outbreak itself and affect a wider group of people include effects on: (1) the healthcare system, (2) water, sanitation and hygiene services, (3) people's safety, (4) educational system, (5) food security and (6) household income [68, 69]. To better understand and develop policies to mitigate some of these impacts, recommendations have included the need to carry out comprehensive analysis of the wider social, economic and political impacts of the epidemic on the affected countries, communities and survivors as well as strengthening health systems and addressing the structural vulnerabilities that hampered containment efforts [70].

7. Conclusions: CSOs and the strengthening of IHS and national health systems

This paper has made an initial case for better embedding CSOs' roles in national health systems as a means of ensuring health security during public health emergencies such as EVD outbreaks. Using the WHO health system framework which comprises six independent but interrelated building blocks as an evaluative framework, this review finds that CSOs have played supplemental albeit critically important roles in filling health systems gaps in a manner that enabled national governments and global actors to contain the West Africa EVD outbreak. These roles have included: (1) support with the establishment of national Ebola response teams for coordinating the overall response, (2) developing surveillance and response systems to detect, track and treat disease, (3) provision and maintenance of safe health care services (e.g., ETUs for isolating patients) together with training of personnel on infection control procedures, (4) supporting the development and use of new vaccines, diagnostic and therapeutic tools, (5) mobilizing and training a wide-range of health workforce including clinicians, non-clinicians and community health workers, and (6) resourcing the epidemic response efforts through innovative funding mechanisms. Together these multiple functions of CSOs have been essential in containing the West Africa EVD outbreak and directs attention to specific areas at the backbone of any response to public health emergency, and where CSO-health system intersections can be particularly leveraged and better strengthened in LMICs. Moreover, this review has underscored several challenges intrinsic to CSOs' and other global actors responding to the epidemic and suggested various recommendations for improvements in their performance.

Finally, if we understand IHS and health systems strengthening as a complex constellation of power relations in which actors (e.g., national governments, multilateral organizations such as the UN and WHO, bilateral and philanthropic donors and CSOs) deploy different types of resources (e.g., knowledge, money or political authority) to pursue diverse organizational interests, then, it is critically important to identify the unique functions CSOs perform within this system. This review sheds more light on such functions drawing on lessons from the implementation of the West Africa EVD response. What is needed is more in-depth understanding of the respective roles played by these varied global health actors working in collaboration with CSOs during public health emergencies. Moreover, beyond this preliminary mapping of CSOs' roles using secondary data, systematic collection of primary data on the full range of global health actors responding to public health emergencies with CSOs as implementing partners is needed to provide a clearer understanding of how profitably CSOs might be better engaged in health crises that cross national boundaries.

Author details

Martin Hushie^{1*}, Rita Suhuyini Salifu² and Iddrisu Seidu³


1 Department of Behavioral Sciences, School of Allied Health Sciences, University for Development Studies, Tamale, N/R, Ghana

2 Health and Development Solutions Network, Tamale, N/R, Ghana

3 Centre for Development and Policy Advocacy, Tamale, N/R, Ghana

*Address all correspondence to: mhushie@uds.edu.gh

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Piot P. *No Time to Lose: A Life in Pursuit of Deadly Viruses*. New York, NY, USA: WW Norton & Company; 2012
- [2] World Health Organization. *Ebola haemorrhagic fever in Sudan, 1976. Report of a WHO/International Study Team*. *Bulletin of the World Health Organization*. 1978;56:247-270
- [3] World Health Organization [Internet]. 2019. Available from: <https://www.who.int/news-room/fact-sheets/detail/ebola-virus-disease> [Accessed: 22 June 2020]
- [4] Center for Disease Control and Prevention. *2014-2016 Ebola Outbreak in West Africa* [Internet]. 2019. Available from: <https://www.cdc.gov/vhf/ebola/history/2014-2016-outbreak/index.html#:~:text=On%20March%2023%2C%202014%2C%20the,epidemic%2C%20the%20largest%20in%20history>. [Accessed: 22 June 2020]
- [5] Safari SB, Baratloo A, Rouhipour A, Ghelichkhani P, Yousefifard M. Ebola hemorrhagic fever as a public health emergency of international concern: A review article. *Emergency*. 2015;3(1):3-7
- [6] Ebola Situation Report [Internet]. 2016. Available from: <http://apps.who.int/ebola/current-situation/ebola-situation-report-30-march-2016>. [Accessed: 23 June 2020]
- [7] Kieny M-P, Evans DB, Schmets G, Kadandale S. Health-system resilience: reflections on the Ebola crisis in western Africa. *Bulletin of the World Health Organization* [Internet]. WHO Press; 2014 Dec 1;92(12):850-850. Available from: <http://dx.doi.org/10.2471/blt.14.149278>
- [8] Kentikelenis A, King L, McKee M, Stuckler D. The international monetary fund and the Ebola outbreak. *The Lancet Global Health*. 2015;3(2):e69-e70
- [9] O'Hare B. Weak health systems and Ebola. *The Lancet Global Health*. 2015;3(2):e71-e72
- [10] Moon S, Sridhar D, Pate MA, Jha AK, Clinton C, Delaunay S, et al. Will Ebola change the game? Ten essential reforms before the next pandemic. The report of the Harvard-LSHTM Independent Panel on the Global Response to Ebola. *The Lancet*. 2015;386(10009):2204-2221
- [11] Williams CL. Leading the charge: Médecins Sans Frontières receives the 2015 Lasker-Bloomberg Public Service Award. *The Journal of Clinical Investigation*. 2015;125(10):3737-3741
- [12] Gostin LO, Friedman EA. A retrospective and prospective analysis of the west African Ebola virus disease epidemic: Robust national health systems at the foundation and an empowered WHO at the apex. *The Lancet*. 2015;385(9980):1902-1909
- [13] Burkle FM. Global health security demands a strong international health regulations treaty and leadership from a highly resourced World Health Organization. *Disaster Medicine and Public Health Preparedness*. 2015;9(5):568-580
- [14] Gostin LO. Global Health security after Ebola: Four global commissions. *The Milbank Quarterly*. 2016;94(1):34-38
- [15] Kluge H, Martín-Moreno JM, Emiroglu N, Rodier G, Kelley E, Vujnovic M, et al. Strengthening global health security by embedding the international health regulations requirements into national health systems. *BMJ Global Health*. 2018;3(Suppl 1):e000656
- [16] WHO. *One Year into the Ebola Epidemic: A Deadly, Tenacious and Unforgiving Virus* [Internet]. 2015.

Available from: <https://www.who.int/csr/disease/ebola/one-year-report/introduction/en/>. [Accessed: 22 June 2020]

[17] Katz R, Sorrell EM, Kornblet SA, Fischer JE. Global health security agenda and the international health regulations: Moving forward. *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*. 2014;**12**(5):231-238

[18] Kamradt-Scott A, Harman S, Nunes J, et al. WHO must remain a strong global health leader post Ebola. *Lancet*. 2015;**385**:111

[19] Heymann DL, Chen L, Takemi K, et al. Global health security: The wider lessons from the west African Ebola virus disease epidemic. *Lancet*. 2015;**385**:1884-1901

[20] Global Health Security Agenda [Internet]. 2020. Available from: <https://ghsagenda.org/> [Accessed: 23 June 2020]

[21] Global Health Policy. The Role of NGOs in the U.S. Global Health Response [Internet]. 2015. Available from: <https://www.kff.org/global-health-policy/issue-brief/data-note-role-of-ngos-u-s-global-health-response/> [Accessed: 23 June 2020]

[22] Scholte JA. *Building Global Democracy? Civil Society and Accountable Global Governance*. Cambridge, England, UK: Cambridge University Press; 2011

[23] Green A, Matthias A. *Non-Governmental Organizations and Health in Developing Countries*. New York: Macmillan Press; 1997

[24] Bebbington A, Hickey S, Mitlin DC. *Can NGOs Make a Difference? The Challenge of Development Alternatives*. London: Zed books; 2008

[25] Hulme D. *Making a Difference: NGO's and Development in a Changing*

World. Abingdon-on-Thames, England, UK: Routledge; 2013

[26] Galway LP, Corbett KK, Zeng L. Where are the NGOs and why? The distribution of health and development NGOs in Bolivia. *Globalization and Health*. 2012;**8**(1):38

[27] Banks N, Hulme D, Edwards M. NGOs, states, and donors revisited: Still too close for comfort? *World Development*. 2015;**66**:707-718

[28] Wallace T. NGO dilemmas: Trojan horses for global neoliberalism? *Socialist Register*. 2009;**40**:40

[29] Merz S. 'Missionaries of the new era': Neoliberalism and NGOs in Palestine. *Race & Class*. 2012;**54**(1):50-66

[30] Wright GW. NGOs and Western hegemony: Causes for concern and ideas for change. *Development in Practice*. 2012;**22**(1):123-134

[31] Nega B, Schneider G. NGOs, the state, and development in Africa. *Review of Social Economy*. 2014;**72**(4):485-503

[32] Ahmed S, Potter DM. *NGOs in International Politics*. Bloomfield, CT: Kumarian Press; 2006

[33] Okma KG, Kay A, Hockenberry S, Liu J, Watkins S. The changing role of health-oriented international organizations and nongovernmental organizations. *The International Journal of Health Planning and Management*. 2016;**31**(4):488-510

[34] Burkle FM Jr. Globalization and disasters: Issues of public health, state capacity and political action. *Journal of International Affairs*. 2006;**59**:241-265

[35] Trinitapoli J. Religious responses to AIDS in sub-Saharan Africa: An examination of religious congregations

in rural Malawi. *Review of Religious Research*. 2006;**47**:253-270

[36] Pfeiffer J. International NGOs and primary health care in Mozambique: The need for a new model of collaboration. *Social Science & Medicine*. 2003;**56**:725-738

[37] Beamon BM, Balcik B. Performance measurement in humanitarian relief chains. *International Journal of Public Sector Management*. 2008;**21**:4-25

[38] WHO. Social Determinants of Health. Civil Society Final Report 2007 [Internet]. 2007. Available from: https://www.who.int/social_determinants/resources/cso_finalreport_2007.pdf?ua=1 [Accessed: 23 June 2020]

[39] WHO. International Health Regulations [Internet]. 2005. Available from: <https://apps.who.int/iris/bitstream/handle/10665/246107/9789241580496-eng.pdf?sequence=1> [Accessed: 23 June 2020]

[40] WHO. The World Health Report 2000: Health Systems: Improving Performance. World Health Organization; 2000. [Internet]. 2000. Available from: https://www.who.int/whr/2000/en/whr00_en.pdf?ua=1 [Accessed: 23 June 2020]

[41] WHO. Health Systems: Key Expected Results [Internet]. 2016. Available from: <https://www.who.int/healthsystems/about/progress-challenges/en/> [Accessed: 23 June 2020]

[42] WHO. Everybody's Business—Strengthening Health System to Improve Health Outcome, WHO'S Framework for Action [Internet]. 2007. Available from: https://www.who.int/healthsystems/strategy/everybodys_business.pdf?ua=1 [Accessed: 23 June 2020]

[43] WHO: Monitoring the Building Blocks of Health Systems: A Handbook

of Indicators and their measurement Strategies [Internet]. 2010. Available from: https://www.who.int/healthinfo/systems/WHO_MBHSS_2010_full_web.pdf [Accessed: 23 June 2020]

[44] Mounier-Jack S, Griffiths UK, Closser S, Burchett H, Marchal B. Measuring the health systems impact of disease control programmes: A critical reflection on the WHO building blocks framework. *BMC Public Health*. 2014;**14**(1):278

[45] Shoman H, Karafillakis E, Rawaf S. The link between the west African Ebola outbreak and health systems in Guinea, Liberia and Sierra Leone: A systematic review. *Globalization and Health*. 2017;**13**(1):1

[46] Cancedda C, Davis SM, Dierberg KL, et al. Strengthening health systems while responding to a health crisis: Lessons learned by a nongovernmental organization during the Ebola virus disease epidemic in Sierra Leone. *The Journal of Infectious Diseases*. 2016;**214**(suppl 3):S153-S163

[47] Pérache A. "To Put Out This Fire, We Must Run into the Burning Building": A review of MSF's Call for Biological Containment Teams in West Africa, Humanitarian Exchange, 64 [Internet]. 2015. Available from: <https://odihpn.org/magazine/to-put-out-this-fire-we-must-run-into-the-burning-building%C2%92-a-review-of-msf%C2%92s-call-for-biological-containment-teams-in-west-africa/> [Accessed: 22 June 2020]

[48] Shin YA, Yeo J, Jung K. The effectiveness of international non-governmental Organizations' response operations during public health emergency: Lessons learned from the 2014 Ebola outbreak in Sierra Leone. *International Journal of Environmental Research and Public Health*. 2018;**15**(4):650. Published 2018 April 1

- [49] DuBois M, Wake C, Sturridge S, Bennett C. The Ebola Response in West Africa: Exposing the Politics and Culture of International Aid—HPG Working Papers—Working and Discussion Papers/68 [Internet]. 2015. Available from: <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9903.pdf> [Accessed: 22 June 2020]
- [50] Crowe S, Hertz D, Maenner M, Ratnayake R, Baker P, Lash R, et al. A plan for community event-based surveillance to reduce Ebola transmission—Sierra Leone, 2014–2015. *MMWR. Morbidity and Mortality Weekly Report*. 2015;64(3):70–73
- [51] Stone E, Miller L, Jasperse J, et al. Community event-based surveillance for Ebola virus disease in Sierra Leone: Implementation of a national-level system during a crisis. *PLOS Curr*. 2016;8
- [52] Dahl BA, Kinzer MH, Raghunathan PL, et al. CDC's response to the 2014–2016 Ebola epidemic—Guinea, Liberia, and Sierra Leone. *MMWR Suppl*. 2016;65(Suppl-3):12–20
- [53] Fowler RA, Fletcher T, Fischer WA, Lamontagne F, Jacob S, Brett-Major D, et al. Caring for critically ill patients with Ebola virus disease. Perspectives from West Africa. *American Journal of Respiratory and Critical Care Medicine*. 2014;190(7):733–737
- [54] Lee-Kwan SH, DeLuca N, Adams M, Dalling M, Drevlow E, Gassama G, et al. Support services for survivors of Ebola virus disease—Sierra Leone, 2014. *MMWR. Morbidity and Mortality Weekly Report*. 2014;63(50):1205
- [55] The Forgotten Ebola Survivors of Sierra Leone [Internet]. 2018. Available from: <https://www.npr.org/sections/goatsandsoda/2018/04/25/604966533/>
- two-years-after-end-of-ebola-crisis-survivors-sue-to-receive-promisedaid?utm_source=Global+Health+NOW+Main+List&utm_campaign=b884df3902-EMAIL_CAMPAIGN_2018_04_26&utm_medium=email&utm_term=0_8d0d062dbd-b884df3902-875843 [Accessed: 22 June 2020]
- [56] Paterson D, Widner J, Godefroy B. Filling Skills Gaps: mobilizing Human Resources in the Fight against EBOLA, 2014–2015. [Internet]. 2017. Available from: https://successfulesocieties.princeton.edu/sites/successfulesocieties/files/DP_Ebola_Personnel_Final_April%2024%202017_0.pdf [Accessed: 22 June 2020]
- [57] Ansell C, Boin A, Keller A. Managing transboundary crises: Identifying the building blocks of an effective response system. *Journal of Contingencies and Crisis Management*. 2010;18(4):195–207
- [58] The Guardian. Ebola Outbreak Response: A Breakdown of the Key Funding Pledges [Internet]. 2014. Available from: <https://www.theguardian.com/global-development/2014/oct/09/ebola-outbreak-response-breakdown-key-funding-pledges> [Accessed: 22 June 2020]
- [59] Global Citizen: 16 Organizations That Are Working to End Ebola in West Africa [Internet]. 2014. Available from: <https://www.globalcitizen.org/en/content/16-organizations-that-are-working-to-end-ebola-in/> [Accessed: 22 June 2020]
- [60] The Ebola Lessons Reader: What's Being Said, What's Missing and Why It Matters International Rescue Committee [Internet]. 2016. Available from: <https://www.rescue.org/sites/default/files/document/563/theebolalessonsreaderlowres.pdf> [Accessed: 22 June 2020]

- [61] State of Emergency: How Government Fought Ebola. Tony Blair Africa Governance Initiative. [Internet]. 2015. Available from: <https://institute.global/sites/default/files/articles/State-of-Emergency-How-Government-Fought-Ebola.pdf> [Accessed: 22 June 2020]
- [62] MSF Operational Centre. Epidemics: Neglected Emergencies? [Internet]. Geneva: MSF Operational Centre; 2015. Available from: https://www.msf.org.uk/sites/uk/files/final_rapport_epidemies_eng.pdf [Accessed: 22 June 2020]
- [63] Gates B. The next epidemic—Lessons from Ebola. *The New England Journal of Medicine*. 2015;372(15):1381-1384
- [64] WHO. Report of the Ebola Interim Assessment Panel [Internet]. 2015. Available from: <https://www.who.int/csr/resources/publications/ebola/report-by-panel.pdf?ua=1> [Accessed: 22 June 2020]
- [65] Glaser E, Davis S, Flomo C, Sliney A, Tiah MW. The Harvard-LSHTM panel on the global response to Ebola report. *The Lancet*. 2016;387(10021):848
- [66] Van Bortel T, Basnayake A, Wurie F, et al. Psychosocial effects of an Ebola outbreak at individual, community and international levels. *Bulletin of the World Health Organization*. 2016;94(3):210-214
- [67] O’Leary A, Jalloh MF, Neria Y. Fear and culture: contextualising mental health impact of the 2014-2016 Ebola epidemic in West Africa. *BMJ Global Health* [Internet]. *BMJ*; 2018 Jun;3(3):e000924. Available from: <http://dx.doi.org/10.1136/bmjgh-2018-000924>
- [68] Beyond a Public Health Emergency: Potential Secondary Humanitarian Impacts of a Large-Scale Ebola Outbreak. 2016. Available from: https://www.acaps.org/sites/acaps/files/products/files/t_beyond_a_public_health_emergency_feb_2016.pdf [Accessed: 22 June 2020]
- [69] United Nations Development Group – Western and Central Africa. Socio-Economic Impact of Ebola Virus Disease in West African Countries A Call for National and Regional Containment, Recovery and Prevention. 2015. Available from: <https://www.undp.org/content/dam/rba/docs/Reports/ebola-west-africa.pdf> [Accessed: 03 July 2020]
- [70] Calnan M, Gadsby EW, Kondé MK, Diallo A, Rossman JS. The response to and impact of the Ebola epidemic: Towards an agenda for interdisciplinary research. *International Journal of Health Policy and Management*. 2018;7(5):402-411

The Importance of Reduction in the Registry of Deaths to Ill-Defined Causes and Their Impact on Mortality Profile: The Brazilian Experience and Its Implications to International Health Security

Davi Félix Martins Junior

Abstract

This chapter aims to describe the strategies implemented by the Ministry of Health since 2004 to reduce deaths classified as ill-defined causes (IDC) and the impacts on the mortality profile. Since 1979, deaths occurring and recorded across the country have been stored electronically on the Datasus website (www.datasus.gov.br), which is in the public domain. From this database, it appears that the proportion of deaths from IDC in the country decreased from 20.1% in 1979 to 5.5% in 2017. In small municipalities, less than 20,000 inhabitants, which have the worst data quality and worse socioeconomic status and with the greatest inequities in health, requiring greater investments, the reduction was smaller. The Ministry of Health implemented several actions that involved suspending the transfer of resources from the federal fund to the municipal fund for non-compliance with the rules for the collection, flow and periodicity of information on deaths, in addition to training and qualification of human resources to record and code the causes of death and to investigate deaths by IDC through verbal autopsy. These are initiatives that can be replicated in other contexts, except, perhaps, of a legal nature, as they fit into the legal system that presents specificities in each country.

Keywords: ill-defined causes, mortality information system, mortality statistics, basic cause of death, mortality, time trend, mortality profile

1. Introduction

Mortality is the most used indicator to make inferences about the health conditions of the groups that make up a given population [1], being used, among others, in the analysis of the momentary situation, in the evaluation of trends in the population's health status and surveillance of health and also in proposing effective measures and interventions in public health policies [2] focused on prevention and

assistance. The use of mortality to describe the health situation depends fundamentally on the information contained in the death certificate (DC), highlighting crucial fields that enable a better characterization of death, such as age, gender, marital status and underlying cause or causes associated. Traditionally, the analysis of deaths is presented through a single cause, the basic cause of death [3], not considering the other conditions informed by the doctor in the death certificate. It is noteworthy that in middle- and low-income countries, death registration and cause-of-death determination are not performed for multiple deaths, and the deaths of the poorest individuals are less likely to be reported [4]. In situations where it is not possible to specify the underlying cause of death, the “underlying cause” field is filled in as ill-defined cause (IDC) representing a major gap in the knowledge of the occurrence of the leading causes of death. Deaths from IDC reduce the potential for mortality as a health indicator by underestimating the rates of a disease or group of diseases, thus falsifying the epidemiological reality, directly impacting intervention measures. Mortality statistics should be of quality to reflect the actual pattern of causes of death in the population.

IDC of death is an indicator to assess the quality of information on causes of death and reflect problems of access to health services, quality of health care provided to the population [5], and the characteristics of completing the death certificate [6]. In addition, there is the lack of conditions for the diagnosis of diseases and, on the other hand, professional training for filling out death certificates [7].

Data on deaths occurring and recorded in the country are stored in the Mortality Information System-SIM/Datasus [8], which was created in 1975, and in the following year, the Ministry of Health unified more than 40 models of instruments used in Brazil for data collection mortality data. This system stores death data that allows the generation of cause-specific mortality indicators that serve to analyze and evaluate systems at all levels of management, from municipal to national level. The SIM was computerized in 1979, whose data are available for reading and using when needed on the Datasus website, www.datasus.gov.br [8]. The official document for collecting information on death is the Death Certificate (DC) and its main characteristics are a single and universal model for the entire national territory, and it maintains the international model proposed by the World Health Organization (WHO) in the cause of death part, standardizing the way to record all other types of information [9]. Death certificate is the name of the official form in Brazil, in which death is attested. For legal purposes, death must be registered with the civil registry office of natural persons and can only be obtained with the death certificate [10]. The process of decentralization resulting from the implementation of the Unified Health System (SUS) made the states and municipalities responsible for collecting death data from 1991 onwards [11]. As for the quality of deaths in the country, there is considerable heterogeneity in the causes of death statistics in Brazilian regions, especially for criteria such as completeness and ill-defined causes [12]. These authors found that from 2002 to 2004 coverage varied significantly between regions, from 72 to 80% in the Northeast, compared to 85 to 90% in the Southeast and Midwest, and 94 to 97% in the South. The distribution of proportional mortality by IDC varied, with the highest proportions being in the states located in the less-developed regions of the country, North and Northeast, and the lowest in the states located in the other regions [13, 14]. In Brazil, in 2003, 95% of undeclared deaths occurred in the North and Northeast regions and 76% of the total deaths reported without the cause of death in the country occurred in these regions [15]. The differences found at the regional scale are replicated at the state scale and even at the intra-municipal scale. The differences in the risk of death by this group of causes reflect the inequalities

in the living conditions of the populations living in each unit of the federation and reflect, among others, the degree of access to health services, availability of medical assistance provided to the population and the characteristics of filling out the death certificate [16]. Regarding the completion of the DC, the need for activities aimed at raising the awareness of the medical professional about the relevance of the DC is emphasized, through continuous training actions that allow the complete and correct completion of the document [17]. The importance given to information and the level of organization of health services can be added to these. From the perspective of health security, the occurrence of deaths from ill-defined causes represents a major problem that directly affects the health management process, as this demands the production of continuous, timely information and needs to be sensitive enough to capture the changes in a situation of health. Health policies must be based on adequate and timely information about the nature and extent of the problems observed, their determinants and the impact on populations [16] to plan health services according to the needs of the population. High proportions of reported deaths classified as ill-defined causes can significantly change mortality rates due to specific diseases [18], on the one hand, and constitute a public health risk, on the other, because it may be a disease with a high transmissible power and spread to the entire population from the affected people and their contacts. This risk varies from the local scale to the global scale.

This study aimed to evaluate the reduction in deaths from ill-defined causes on the mortality profile of the Brazilian population from 1979 to 2017.

2. Methods

A time series study with secondary data from the SIM/Datasus/MS Mortality Information System was performed. This system stores data on deaths that occurred and were recorded in Brazil and has been available for reading and using when needed since 1979 on the Datasus website www.datasus.gov.br [8]. The computerization of the death registration through SIM/Datasus has allowed to monitor mortality in the country due to underlying cause or associated causes and also according to some demographic characteristics such as gender and age, and it is also possible to analyze the geographic distribution of deaths, which has a smallest space unit, the municipality. This system is an important management tool in the health area and its management at the federal level is affected by the Health Surveillance Secretariat.

The present study considered ill-defined causes of death allocated in Chapter XVI of the International Classification of Diseases (ICD 09)—Symptoms, Signs and Ill-Defined Diseases and Chapter XVIII of the 10th Revision of ICD—Symptoms, Signs and Abnormal Findings, Clinical and Laboratory Examinations (codes R00–R99). We adopt this because among the different initiatives developed by the Ministry of Health with a view to reduce underreporting and the high proportions of deaths from IDC in the North and Northeast regions responsible for the highest proportions of deaths classified under this heading in the country, we highlight the program “Reduction in the percentage of deaths with ill-defined causes.” This program was established by the Ministry of Health in 2004 and aimed to reduce the proportion of deaths from Chapter XVIII [19]. Using the number of deaths from ill-defined causes in the numerator and the total number of deaths in the denominator, we calculated proportional mortality from ill-defined causes (IDC) by age group (0–4; 5–19; 20–29; 30–39; 40–49; 50–59; 60+ and total for the period 1979–2017) and by municipality population size (up to 10,000; 10,001–25,000; 25,001–50,000;

50,001–100,000; 100,001–500,000; 500,001– and more, for the years 1996 and 2017). The year 1996 was taken as reference because it was the year in which Brazil adopted the ICD-10 in the classification of causes of death; 1979 is the first year from which data are available for capturing that are stored in SIM and 2017 is the last year in the data series.

3. Results

Figure 1 shows the temporal trend of proportional mortality from ill-defined causes from 1979 to 2017. Rates grew with small swings from 1979 (20.1%) to 1984, the year that reached the highest rate, 22.5%. It then followed a downward trend and last year the rate stood at 5.5%.

The distribution of proportional mortality by IDC according to age group shown in **Table 1** shows that in 1996 the rates ranged from 1.8% in the 5- to 19-year-old group, rising to 2.7% in the subsequent age group and reaching 63.4% in the elderly, people aged 60 and over. In the strata, the lowest rate was observed in young adolescents (7.1%) and the highest in the elderly 18.2%. In 2017, a similar rate in the first two age groups was 1.7%, reaching 3.0% in the 20–29 age group and 68.2% in the elderly. The distribution of rates in the strata ranged from 2.9% in children aged 0–4 years to 6.0% in the age group of 40–49 years. There was a significant reduction in the proportion of deaths from IDC of around 63.7% and ranged from 44.6% in the 30–39 age group to 78.4% in children. In the 2 years under analysis, the elderly (60 years and over) accounted for the highest proportion of deaths from CDM, 63.4% in 1996, rising to 68.2% in 2017.

In 1996, there were 4974 municipalities in the country, of which 2195 (44.1%) had up to 10,000 inhabitants and whose proportion of deaths from ill-defined causes was of the order of 26.8% (**Table 2**). The municipalities with up to 25,000 inhabitants registered the highest proportional mortality by IDC, 29.8%, decreasing then with the increase in the population size, reaching the rate of 6.7% in the most populous municipalities. Due to multiple breakdowns, the number of municipalities in the country has grown to 5571 units. Of the 5571 municipalities in the country, in year 2017, 2450 (44.0%) had up to 10,000 inhabitants, and the proportion of deaths from IDC was 6.4%. Proportional mortality by IDC in 2017

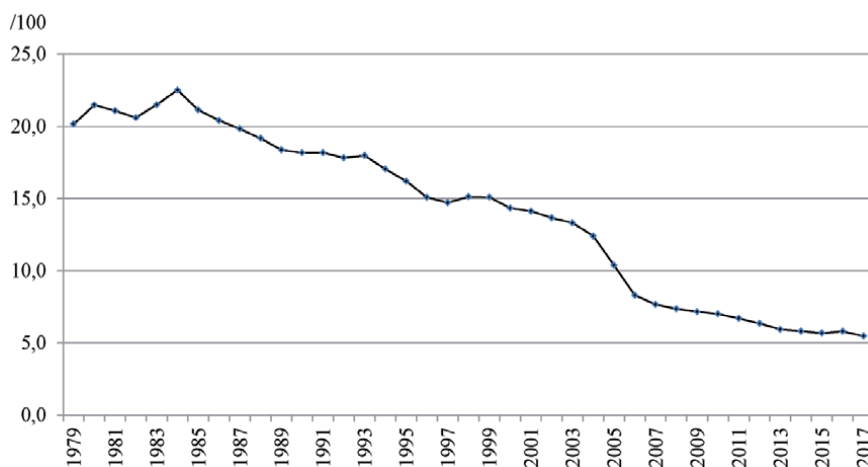


Figure 1. Mortality rate from ill-defined causes, Brazil, 1979–2017; source: SIM/Datasus.

Age range	1996			2017			Var % 2017/1996 in extract
	N° total of deaths	% death IDC in extract	% IDC in total	N° total of deaths	% ób IDC in extract	% ób IDC in total	
0–4	87.769	13,5	8,6	42.141	2,9	1,7	–78,4
5–19	31.749	7,6	1,8	29.376	4,0	1,7	–46,7
20–29	52.380	7,1	2,7	55.755	3,9	3,0	–45,4
30–39	65.770	10,0	4,8	63.776	5,6	4,9	–44,6
40–49	80.820	12,3	7,3	89.177	6,0	7,5	–51,0
50–59	102.738	13,2	9,9	153.293	5,6	12,0	–57,4
60 and more	477.765	18,2	63,4	876.178	5,6	68,2	–69,3
Total	908.883	15,1	100,0	1.312.663	5,5	100,0	–63,7

Source: SIM/Datasus. 1996, the year that ICD-10 was adopted in the codification of diseases; 2017, the last year with available mortality data.

Table 1.
Proportional mortality due to ill-defined causes and temporal variation according to age group, Brazil, 1996 and 2017.

Population Category	1996			2017			Var % 2017/1996
	Death IDC	Death total	%	Death IDC	Death total	%	
Up to 10,000	15.297	57.132	26.8	5.558	86.664	6.4	–76.0
10,001–25,000	37.316	125.172	29.8	12.679	171.860	7.4	–75.3
25,001–50,000	27.068	102.481	26.4	10.794	156.397	6.9	–73.9
50,001–100,000	21.177	109.533	19.3	9.820	154.669	6.3	–67.2
100,001–500,000	28.526	223.568	12.8	18.465	343.437	5.4	–57.9
500,001 and more	18.813	282.609	6.7	85.834	1.709.365	5.0	–24.6
Total	148.197	900.495	16.5	143.150	2.622.392	5.5	–66.8

Source: SIM/Datasus. 1996, the year that ICD-10 was adopted in the codification of diseases; 2017, the last year with available mortality data.

Table 2.
Proportional mortality due to ill-defined causes and percentage variation according to population size classes, Brazil, 1996 and 2017.

ranged from 5.0% in the largest municipalities (500,001 thousand inhabitants and more) to 7.4% in the municipalities with a population of 10,001 to 25,000 inhabitants. The proportion of deaths from IDC decreased in all population strata, being greater than 70% in municipalities with up to 50,000 inhabitants, which is higher than the national average of 66.8% (from 16.5% in 1996 to 5.5% in 2017). In the large municipalities, the reduction was around 24.6% (6.7% to 5.0%).

4. Discussion

Brazil is the largest country in South America with significant regional socio-economic differences affecting the living and working conditions in which individuals

and the population group live and which are directly related to their health situation, that is, configuring the social determinants of health [20]. These adverse conditions cause health problems and create situations of potential risk, affecting the health of individuals and certain segments of the population. Significant differences are also observed in the organization and structuring of public services that affect, among others, the registration of vital information, whether due to lack of coverage or problems in filling out the forms related to this information. Given the situation identified in recent decades, the federal government, through the Ministry of Health, has made significant investments in various initiatives aimed at improving the quality of vital information in the country. Regarding deaths, attention has been focused on improving the coverage of deaths and reducing, to the maximum, the number of deaths classified under the heading of ill-defined cause.

Investments made include the regulation of data collection, flow and periodicity of information on death by means of Ordinance No. 116 of February 11, 2009 [21], and the suspension of fund-to-fund transfer in the event of problems in submitting this information, initially through Ordinance GM 3252 of December 22, 2009 [22], and currently Ordinance No. 1378/GM/MS of July 9, 2013 [23].

In addition to these decrees, training programs for human resources and coders of basic causes are associated with the dissemination of data and technical publications, such as “Saúde Brasil,” based on the use of data from information systems, thus seeking greater use of indicators of health by managers [24]. Another important initiative was the study of the active search for deaths and births in the Northeast and the Legal Amazon with the main objective of estimating the coverage of the Mortality Information System (SIM) and the Information System on Live Births (SINASC) in 133 municipalities of these regions. The statistical procedure used for data analysis allowed the estimation of infant mortality in all municipalities [25].

Regarding the improvement of the definition of the cause of death, the program “Reduction of the percentage of deaths with ill-defined causes” was instituted in 2004, developed by the Health Surveillance Secretariat of the Ministry of Health. This program aimed to investigate deaths from ill-defined causes and establish a goal to reduce the percentage of these deaths in the Northeast region and in three states in the North region (Acre, Pará and Amazonas) to less than 10% [26]. In 2006, the National Network of Mortality Cause Verification and Death Verification Services (SVO) was created considering the need for the implementation of SVO in all state capitals and the Federal District, which should total 74 services [27] to insert these structures on the National Health Surveillance System. In addition, a new instruction manual to fill a DC from 2011 was widely disseminated and distributed, seeking greater awareness of the medical professional regarding the importance of correct and complete filling of this document [9].

The creation of Hospital Epidemiology Centers (NUHEPI), within the hospital, and the Epidemiological Surveillance Units (UVE), in Family Health Centers, as well as the implementation of the form to investigate deaths from ill-defined causes, the training of typists and coders, and awareness-raising workshops for professionals responsible for filing a DC from 2006 onwards, represented a major contribution to this new reality [16].

All measures of a legal nature, by suspending the transfer of funds from the federal fund to the municipal fund, in case of non-compliance with the rules for the collection, flow and periodicity of information on deaths, in addition to training and qualification of human resources to record and code the underlying cause and to investigate deaths by IDC through verbal autopsy, reduced the occurrence of deaths classified as IDC. According to data presented in this article, there is a pronounced reduction in ill-defined causes for the country as a whole, which proves

the effectiveness of this set of actions. These are initiatives that can be replicated in other contexts with the exception, perhaps, of a legal nature, as they fall within the legal system that presents specificities in each country. Among the limitations of this study is the unit of analysis that considered the country as a whole. The use of a smaller spatial unit as a microregion or even a municipality would make it possible to identify the municipalities where the impact of the actions did not achieve the expected success, that is, where the problems of assistance, registration and classification of deaths persist.

5. Conclusion


The unequal distribution of deaths according to underlying cause expresses the inequity of access to health services by the population and problems of structuring and organization of health services. The uneven geographical distribution of deaths due to this type of causes requires geographically differentiated interventions in order to reduce its occurrence. This set of problems is a major challenge for public administration to achieve an even more pronounced reduction in deaths from ill-defined causes. The continuous search for improvement of health statistics necessarily involves reducing the frequency of deaths classified under this heading.

Author details

Davi Félix Martins Junior
Universidade Estadual de Feira de Santana -UEFS, Brazil

*Address all correspondence to: dmartins@uefs.br

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Pereira MG. *Epidemiologia Teoria e prática*. Rio de Janeiro: Guanabara Koogan; 2006
- [2] Redelings MD, Sorvillo F, Simon PA. Comparison of underlying cause and multiple causes of death: US vital statistics, 2000-2001. *Epidemiology*. 2006;**17**:100-103
- [3] Santo AH. Potencial epidemiológico da utilização das causas múltiplas de morte por meio de suas menções nas declarações de óbito, Brasil, 2003. *Revista Panamericana de Salud Pública*. 2007;**22**:178-186
- [4] Leitao J et al. Revising the WHO verbal autopsy instrument to facilitate routine cause-of-death monitoring. *Global Health Action*. 2013;**6**:21518
- [5] Campos D, França E, Loschi RH, Souza MFM. Uso da autópsia verbal na investigação de óbitos com causa mal definida em Minas Gerais, Brasil. *Cadernos de Saúde Pública*. 2010;**26**:1221-1233
- [6] Silvi J. On the estimation of mortality rates for countries of the Americas. *Epidemiological Bulletin*. 2003;**24**:1-5
- [7] Rede Interagencial de Informações para a Saúde & Pan American Health Organization. Indicadores básicos para a saúde no Brasil: conceitos e aplicações. Organização Pan Americana da Saúde; 2008. p. 349
- [8] Brasil. Ministério da Saúde. Datasus— Sistema de Informações em Saúde. 2019. Available from: <http://www2.datasus.gov.br/DATASUS/index.php?area=0205>
- [9] Brasil. Ministério da Saúde. Manual de Instruções para o preenchimento da Declaração de Óbito. Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Análise de Situação de Saúde; 2011. p. 54
- [10] Brasil. Ministério da Saúde. A declaração de óbito: documento necessário e importante. Conselho Federal de Medicina, Centro Brasileiro de Classificação de Doenças; 2009. p. 38
- [11] Brasil. Ministério da Saúde, Pan American Health Organization & Fundação Oswaldo Cruz. A experiência brasileira em sistemas de informação em saúde. Editora MS; Textos Básicos de Saúde. 2009
- [12] França E, de Abreu DX, Rao C, Lopez AD. Evaluation of cause-of-death statistics for Brazil, 2002-2004. *International Journal of Epidemiology*. 2008;**37**:891-901
- [13] Santo AH. Causas mal definidas de morte e óbitos sem assistência. *Revista da Associação Médica Brasileira*. 2008;**54**:23-28
- [14] Martins Junior DF, Costa TM, Lordelo MS, Felzemburg RDM. Tendência dos óbitos por causas mal definidas na região Nordeste do Brasil, 1979-2009. *Revista da Associação Médica Brasileira*. 2011;**57**:338-346
- [15] Brasil. Ministério da Saúde. Manual para Investigação do Óbito com Causa mal Definida; 2008
- [16] Pinto CHCC, Gurgel MGI, Alves MDS, Passos MLL, Diniz SAN, Conceição MR. Investigação de óbitos por causas mal definidas: Estratégia de fortalecimento da vigilância em saúde. *Rev Rene*. 2012;**13**(4):871-879
- [17] Cunha CC, Teixeira R, França E. Avaliação da investigação de óbitos por causas mal definidas no Brasil em 2010. *Epidemiologia e Serviços de Saúde*. 2017;**26**(1):19-30. DOI: 10.5123/S1679-49742017000100003
- [18] Martins Junior DF, Felzemburg RDM, Dias AB, Costa TM, Santos PNP. Trends

in mortality from ill-defined causes among the elderly in Brazil, 1979-2013: Ecological study. *São Paulo Medical Journal*. 2016;**134**(5):437-445. DOI: 10.1590/1516-3180.2016.0070010616

[19] Brazil. Ministério da Saúde. Sistemas de informações sobre mortalidade (SIM) e nascidos vivos (Sinasc) para os profissionais do Programa Saúde da Família. Editora MS; 2004

[20] Buss PM, Pellegrini FA. A Saúde e seus Determinantes Sociais. *Physis: Revista de Saúde Coletiva*. 2007;**17**(1): 77-93

[21] MS. Portaria no. 116, de 11 de fevereiro de 2009. Regulamenta a coleta de dados, fluxo e periodicidade de envio das informações sobre óbitos e nascidos vivos para os Sistemas de Informações em Saúde sob gestão da Secretaria de Vigilância em Saúde. *Diário Oficial da União, Brasília (DF)*

[22] Portaria_GM_3252_de_22_dezembro_de_2009 Aprova as diretrizes para execução e financiamento das ações de Vigilância em Saúde pela União, Estados, Distrito Federal e Municípios e dá outras providências. *Diário Oficial da União, Brasília, 23 de dezembro de 2009. Seção 1, p. 65*

[23] Portaria GM 1378, de 09 de julho de 2013. Regulamenta as responsabilidades e define diretrizes para execução e financiamento das ações de Vigilância em Saúde pela União, Estados Distrito Federal e Municípios, relativos ao Sistema Nacional de Vigilância em Saúde e Sistema Nacional de Vigilância Sanitária. *Diário Oficial da União, Brasília, 10 de julho de 2013. Seção 1, p. 48*

[24] Frias PG, Pereira PMH, Andrade CLT, Lira PIC, Szwarcwald CL. Avaliação da adequação das informações de mortalidade e nascidos vivos no Estado de Pernambuco, Brasil. *Cadernos de Saúde Pública*. 2010;**26**:671-681

[25] Saúde Brasil 2010: was adopted in the codification of diseases análise da situação de saúde e de evidências selecionadas de impacto de ações de vigilância em saúde/Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Análise de Situação em Saúde. Brasília: Ministério da Saúde, 2007. 372 p.: il. (Série G. Estatística e Informação em Saúde)

[26] Cunha CC. Avaliação do programa de redução do percentual de óbitos por causas mal definidas no Brasil em [Tese de doutorado]. Belo Horizonte; 2017

[27] Portaria nº 1405 de 29 de junho de 2006. Institui a Rede Nacional de Serviços de Verificação de Óbito e Esclarecimento da Causa Mortis (SVO). *Diário Oficial da União, Brasília, de junho de 2006. Seção 1, p. 29*

The Relationship of Adulthood Chronic Disease and Adverse Childhood Experiences (ACEs): Implications Regarding Prevention and Promotion in International Health

Jordan Holter, Christine Marchionni and Bankim Bhatt

Abstract

Several studies, including the innovative 1998 ACE Study by CDC-Kaiser Permanente, have assessed the association among adulthood chronic disease and the prevalence of maladaptive, health-harming behaviors including: excessive alcohol use, tobacco use, physical inactivity, psychiatric illness including suicidal ideation or attempts, promiscuous sexual behavior (>50 sex partners), history of STI/STD and severe obesity (obesity (BMI > 35 kg/m²)), subsequent to an individual's exposure to adverse childhood experiences (ACEs). Individuals that have encountered numerous instances of ACEs are almost twice as likely to die before the age of 75, demonstrating a dose-dependent relationship between the instances of ACEs and an increased morbidity/mortality in regard to chronic disease. This excerpt examines the contribution of ACEs to chronic disease and the consequential maladaptive behavior to said adversity, the consequential physiologic and biomolecular changes explained by the Biological Embedding of Childhood Adversity Model in addition to the implications of recounted ACEs on international health security in regard to concepts like conflict, displacement and food insecurity. The apparent association among adulthood chronic disease and ACEs demand changes that promote preventative processes as a means to address the implications these interconnections have on international health.

Keywords: adverse childhood experiences, biological imbedding, childhood adversity, child abuse, child health, dysfunction, trauma, traumatogenic, inflammation, health-harming behavior, behavioral health, chronic disease, chronic illness, prevention, public health, psychiatry, international health, vulnerability

1. Introduction

Chronic disease as defined by the U.S. National Center for Health Statistics is a disease that is pervasive and persists 3 months or more. About 60% of adults in the United States possess a chronic disease meanwhile about 40% possess two or more

diagnoses indicative of chronic disease [1]. By 2030, it is predicted that the U.S. population, predominantly individuals age 65 years and older, could possess three or more chronic diseases [2]. Non-communicable chronic diseases such as: coronary artery disease, ischemic heart disease, asthma, COPD, chronic bronchitis, emphysema, Alzheimer's disease, stroke, hepatic disease, type 1 diabetes, type 2 diabetes, depression, PTSD and an assortment of cancers, possess significant implications pertaining to international health. Chronic disease is a predominant cause of premature death and disability.

In 2016, direct domestic costs related to the medical management of chronic disease approximated 6% of the GDP, including roughly \$3.3 trillion in indirect costs like work loss, worker replacement and diminished economic productivity [3]. Direct costs average approximately \$3300 per person and indirect costs average approximately \$7901 per person [2]. Examples of the financial implications of chronic disease include \$189.6 billion in care expenditures that comprise the management of diabetes and the \$185.9 billion that comprise the management of Alzheimer's disease [3]. These totalities pose significant problems to the patient, the relatives of the patient, employers and the economy. The increase in the prevalence of chronic disease certainly will increase direct costs, indirect costs and expenditures in the U.S. healthcare system.

Several studies have attempted to ascertain the predisposition for chronic disease in particular individuals. The innovative and inventive 1998 CDC-Kaiser Permanente Adverse Childhood Experiences (ACE) study validates the interconnection of chronic disease states and health-harming behaviors subsequent to the exposure of adverse childhood experiences. This retrospective study surveyed 13,494 patients with 9508 respondents by use of their health history and a health appraisal questionnaire. The ACE study and successive similar studies acknowledge the importance of potential prevention of adverse childhood experiences because of their contribution to chronic disease through maladaptive adulthood behaviors that perpetuate pathologic conditions. Through early identification of these interconnections that predispose individuals to costly chronic disease, practitioners and medical organizations anticipate having the ability to address and advocate for the appropriate deterrence of adverse childhood experiences that contributes to the development of chronic disease in adulthood.

2. Methodology

Previous studies, such as the prominent Adverse Childhood Experiences (ACE) study by CDC-Kaiser Permanente that considers the correlation among chronic disease in adulthood and adverse childhood experiences, employed substantiated surveys. These substantiated surveys included an assortment of adverse exposures, categorized as abuse, neglect or adversity in the household. Said surveys were devised using pre-existing published surveys like the Behavioral Risk Factor Surveillance System (BRFSS) survey. Accordingly, several analogous studies, including prospective study of one's childhood and retrospective study that recalls one's childhood, arose that included use of similar substantiated surveys. Additionally, multivariable logistic regression models were used to adjust odds ratios (OR) and confidence intervals (CI) that assess for associations among ACEs and adulthood chronic disease.

A website search engine was used to assist in the selection of an assortment of studies. Scholarly sources such as the National Library of Medicine, particularly the National Center for Biotechnology Information including peer-reviewed literature catalogs like PubMed was used. Inclusion criteria included: sample sizes of at least

100 patients, a population of patients at least 18 years of age, the ability to assess for multiple ACEs, the ability to assess prevalence of ACEs among a diverse patient population pertaining to age, gender, race, ethnicity and education and statistical analysis of the correlation among the instances of ACEs and likelihood of chronic disease in adulthood.

3. What is an adverse childhood experience?

Adverse Childhood Experiences (ACEs) are defined as direct or indirect childhood abuse and domestic disruption before the age of 18, denoted by seven categories in the health appraisal questionnaire including: psychological abuse, physical abuse, sexual abuse, substance abuse, domestic violence, psychiatric illness including suicidal ideation or attempt and incarceration. Studies illustrate that individuals that have encountered ACEs are likelier to engage in maladaptive, high-risk, health-harming behaviors that typically commence at the age of adolescence. The maladaptive adulthood behaviors that contribute to chronic disease include: excessive alcohol use, tobacco use, physical inactivity, psychiatric illness including suicidal ideation or attempts, promiscuous sexual behavior (>50 sex partners), history of STI/STD and severe obesity (BMI > 35 kg/m²), resulting from unhealthy diet.

4. Relationship among ACEs and chronic disease

Throughout the years, several studies, including the influential ACE study, have recognized the relationship among early exposure to ACEs and the prevalence of chronic disease. ACE exposure predisposes individuals to poorer physical and mental health in comparison to individuals that do not encounter ACEs because of a higher likelihood that said individuals partake in high-risk behavior that is detrimental to their health [4]. Fifty six percent of individuals that lack exposure to ACE possessed none of the high-risk behaviors that are linked to chronic disease, meanwhile merely 14% of individuals that encountered 4 or more ACEs possessed none of the high-risk behaviors [5]. An average of 54.5% of individuals who encountered one instance of ACE encountered multiple instances of ACEs throughout their childhood. Repeated exposures to ACEs exacerbate the high-risk, health-harming behaviors that increase the likelihood of an individual developing chronic disease in adulthood. Individuals that encountered 6 or more ACEs are 1.7 times more likely to die before the age of 75 [6]. This affirms a dose-dependent relationship among the number of ACEs encountered and the likelihood that an individual possesses the high-risk behavior that results in a higher morbidity and mortality in regard to their chronic disease (**Figure 1**).

Unfortunately, ACEs are common in the early years of development with the most prevalent being exposure to substance abuse (25.6%) while the least prevalent is exposure to criminal behavior including incarceration (3.4%). Several studies use an odds ratio (OR) in an attempt to assess the association among ACE exposure and consequent maladaptive behaviors that precipitate the development of chronic disease. To illustrate the association among exposure and outcome, recall that an OR greater than 1 means that there are greater odds of an association among exposure and outcome. A modest association for physical inactivity, severe obesity and diabetes (OR less than 2) is present in individuals encountering at least 4 ACEs. A moderate association (OR 2–3) is present for smoking, excessive alcohol use, tobacco use, cardiovascular disease, respiratory disease and cancer in addition to substandard self-reported health. Likewise, excessive alcohol and tobacco users are approximately six-times likelier to have encountered an ACE. A strong association

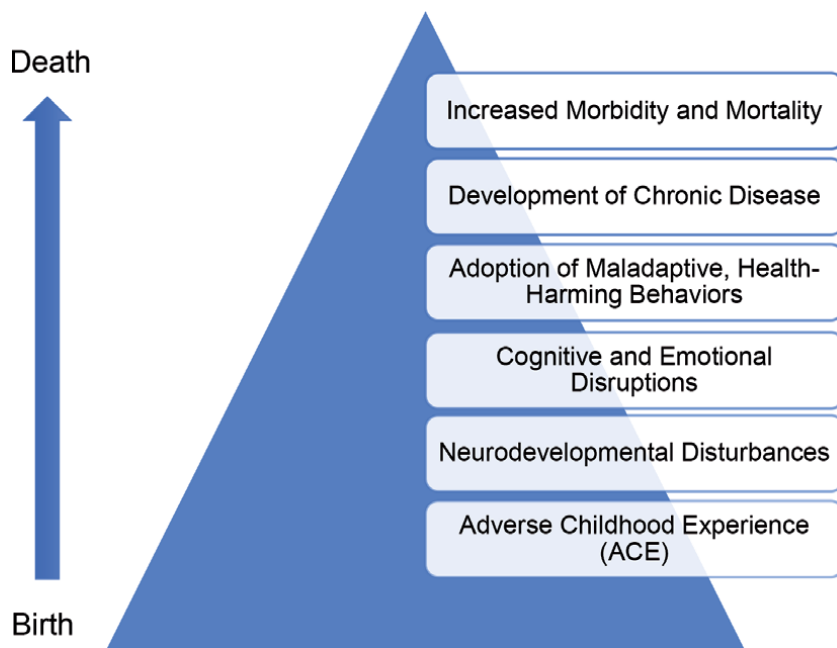


Figure 1.
ACEs effects on health and well-being as adapted from Felitti et al. [5].

(OR 3–6) is present for promiscuous sexual behavior, the presence of an STD/STI and mental illness including depression or PTSD. The strongest association (OR greater than 7) is present for substance abuse and suicidal ideation or attempt secondary to a diagnosis of mental illness like depression or PTSD. Notably, individuals that have a pre-existing diagnosis of PTSD possess twice the odds of coronary artery calcification, contributing to poor cardiovascular health and complications of chronic disease. In general, an OR for maladaptive, high-risk behavior and morbidities increased as ACE scores increased to 4 or more. This affirms that a strong dose-response relationship exists pertaining to the number of ACEs encountered and the likelihood that health-harming behavior contributes to premature death in individuals diagnosed as having a chronic disease [7].

Aside from studies that assess for a direct correlation among instances of ACE and the development of chronic disease, incidences of international health detriments like food insecurity, armed conflict and displacement are higher in populations that admit to one or more ACEs. In the United States, 19.5% of households with children reported food insecurity [7]. In comparison, the Central African Republic comprised of the countries: Burundi, Comoros, Democratic Republic of Congo, Eritrea, Libya, Papua New Guinea, Somalia, South Sudan and Syria, reported food insecurity in 46% of households, secondary to famine [7]. Individuals that encountered 4 or more ACEs were five times more likely to encounter food insecurity in their household versus individuals that denied encountering an ACE [8]. Also, individuals that endorse 4 or more ACEs in addition to depression are associated to an approximate 30-fold increase in food insecurity. This illustrates that ACEs are an important predictor for food insecurity, regardless of the presence or absence of depression. Displacement, a common consequence of armed conflict and violence, is an international concern. Internationally, more than 1 in 10 children are affected by armed conflict. The SABE-Columbia survey, comprised of 23,694 Columbian respondents, 60 years and older, illustrates that displacement throughout one's childhood correlates with at least one chronic illness

in approximately 68% of respondents [9]. A 2018 study surveying approximately 8000 children that encountered armed conflict or displacement exposed significant prevalence of PTSD (47%), depression (43%) and anxiety (27%) [10]. Several studies illustrate a predisposition and an increased risk of ill-health into adulthood as a result of an inappropriate activation of biological and behavioral mechanisms commonly identified in conditions like PTSD and the aforementioned mood disorders. Therefore, it is fundamental to recognize at-risk patient populations in regard to their exposure to international health detriments to mitigate their high risk of chronic disease development.

5. Proposed mechanisms

ACE exposure results in a higher likelihood of developing chronic disease as an adult because of proposed mechanisms that alter an individual's development. This is resultant of recurrent physiologic and biomolecular damage, termed allostatic load. A proposed mechanism pertaining to allostatic load, accepted by the ACE study, is the Biological Embedding of Childhood Adversity Model. This model states that as stress accumulates from abuse, maltreatment or abandonment, a threshold is attained [11]. Attainment of this threshold promotes pro-inflammatory cellular predispositions including a disproportionate cytokine response to the posed challenge that desensitizes the inhibition of hormone signals. Studies suggest that inflammation is the fundamental mediator that translates an adolescent's altered psychosocial influences into biological predisposition for chronic disease. Adults that incurred adverse childhood experiences encountered an elevation in inflammation biomarkers, exacerbated by concurrent mood disorders like depression at the time of assessment. The lack of hormone inhibition and resultant hormonal deregulation stimulates impaired self-regulation in an individual that is already likely to possess genetic predisposition to develop adulthood chronic disease. The Biological Embedding of Childhood Adversity Model explains the alteration of an individual's neural, endocrine, immune, metabolic axes through recurrent negative stressors in the stages of life that are susceptible to such insults. These changes mediate one's cognition and emotional wellbeing as an adult that pose complications in and of itself (**Figure 2**).

The brain and neural development in the first 2 years of life is crucial. The brain acquires 80–90% of gray and white matter throughout this time prior to adulthood advancement [12]. Aside from possible changes in the acquisition of gray and white matter, normal neurodevelopment of the brain enables environmental alterations to essentially inactivate neural synapses. This is referred to as “pruning.” This illustrates the susceptibility that the young developing brain has regarding adverse experiences. ACEs are linked to pervasive and calculable changes in the structure and the function of the brain. Functional MRI has illustrated the structural and functional implications of ACE-mediated risk on psychopathologies including maladaptive adulthood behavior like substance use/abuse as depicted by changes in reward-related cognition including the prefrontal complex and mesolimbic systems. Brain anatomy including the prefrontal cortex, critical in regard to higher-level cognition, is diminished in individual's that experience ACEs as seen in functional MRI studies [12]. Additionally, the limbic system, i.e. the hippocampus and the amygdala, are instrumental in an individual's ability to recall, regulate emotion and learn. This is diminished as a result of adverse experiences, since the limbic system is deemed “stress sensitive” because of the overabundance of glucocorticoid receptors. The neurotoxicity hypothesis implies that early elevation in glucocorticoids in the anatomical regions of the brain that includes the pre-frontal cortex and limbic system, hinders the development of neurons through oxidative stress subsequent to

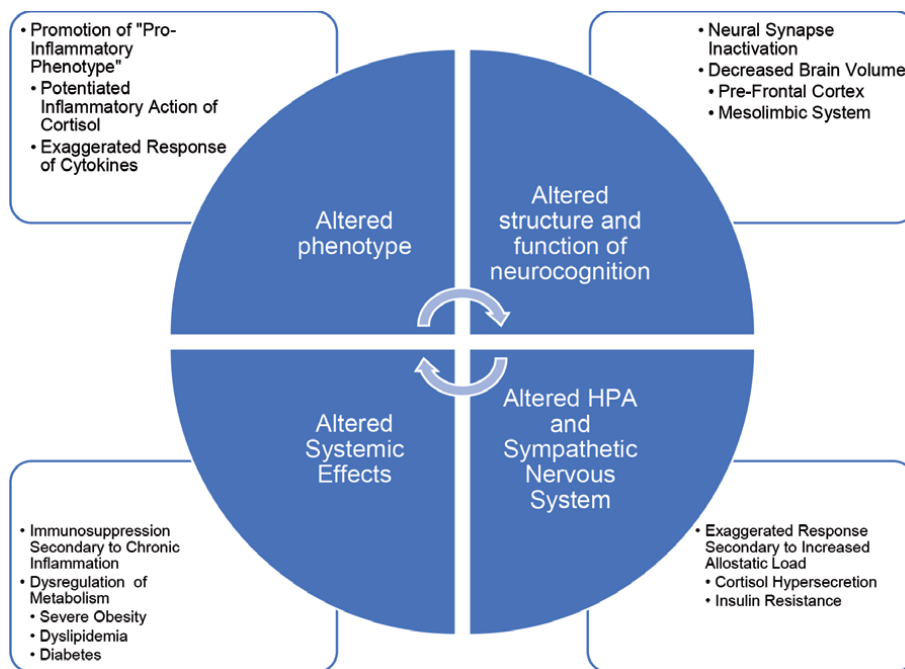


Figure 2.

The biological embedding of childhood adversity model resultant of early exposure psychosocial stressors as adapted from Berens [12].

elevated cortisol. An elevation in cortisol and the subsequent elevation in inflammatory cytokines and excitatory amino acids like glutamate potentiate this hindrance.

The Hypothalamic-Pituitary-Adrenal (HPA) axis and the autonomic axes, involving the sympathetic and parasympathetic nervous system, are fundamental in an individual's response to stressors through release of molecular mediators like corticotrophin-releasing hormone (CRH), adrenocorticotrophic hormone (ACTH) and glucocorticoids. An individual's exposure to ACEs promotes adulthood HPA deregulation through an exaggerated hyper- or hypoactive response secondary to an increased allostatic load. Increased allostatic load promotes physiologic and bio-molecular changes related to the development of chronic disease [13]. Sympathetic activation by the brainstem induces adrenal-medullary epinephrine/norepinephrine output to organs like the heart, liver, pancreas. Conversely, parasympathetic activation significantly mitigates this response to stressors. Autonomic dysregulation and imbalance implies deleterious stress-sensitive alterations by an increased allostatic load which has the propensity to predispose individuals to chronic disease through a predictable response by stress-sensitive organ to the excess hormones. This results in cardiovascular and metabolic derangements. Detrimental metabolic changes include severe obesity, dyslipidemia and diabetes. These changes transpire through the dysregulation of catabolism and anabolism. The balance between catabolism and anabolism is achieved through the regulation of hormones, i.e. cortisol, glucagon, epinephrine/norepinephrine and insulin. Exposure to ACEs stimulates inflammation and the hypersecretion of cortisol, stimulating catabolism. This results in resistance of peripheral tissues to insulin and an ensuing increase in blood glucose levels.

The response to internal and external stimuli is mediated by innate and adaptive immune systems. Regularly, this response results in an appropriate elevation in inflammatory mediators that include tumor necrosis factor, nuclear factors and interleukins. Conversely, chronic elevation in inflammation results in a prevailing immunosuppressed state secondary to cytotoxic, oxidative stress. Studies affirm

that this state of immunosuppression, portrayed as a “pro-inflammatory phenotype,” potentiates the anti-inflammatory action of cortisol through the resistance of downstream receptors [14]. The pro-inflammatory state that promotes immunosuppression has implications on predisposing individuals to chronic ailments related to the development of oncologic disease through the inability of the immune system to impede oncogenic viruses. This increases an individual’s likelihood that a precursory, precancerous condition becomes malignant. Additionally, the role of a pro-inflammatory state is apparent in cardiovascular and metabolic diseases like coronary artery disease and diabetes [15].

6. Examples of inflammation and allosteric load in chronic disease

Chronic inflammation is a hallmark of cardiovascular disease. Initially, cardiovascular disease, specifically coronary artery disease, was deemed a cholesterol storage disorder described by the accumulation of cholesterol in the walls of the arteries. Nonetheless, studies have shown that the presence of an elevated serum inflammatory marker is a significant predictor of cardiovascular risk irrespective of an individual’s lipid profile. Also, elevated inflammatory markers correlate to a recurrent risk of complications including myocardial infarction, peripheral artery disease and stroke in individuals diagnosed as having acute coronary syndrome. Common cardiovascular risk factors like hypertension, hyperglycemia and tobacco use promote a pro-inflammatory phenotype through vascular injury. The propagation of the pro-inflammatory state through recruitment of inflammatory mediators transpires through transformation of lipoproteins to fatty streaks. The accumulation of coagulation factors promotes the propagation of inflammation and destabilizes the plaque. This state promotes cardiac complications like myocardial infarction, peripheral artery disease and stroke. This cascade of chronic inflammation considerably worsens an individual’s cardiovascular condition.

Several studies have illustrated the importance of inflammation in pathophysiology of type 1 (T1D) and type 2 diabetes (T2D). The pathophysiology of T1D is described as an autoimmune phenomenon caused by the inflammation of beta cells of the pancreas, referred to as insulinitis. The predominance of inflammation is mediated through inflammatory mediators that increase in metabolic stress. A peri-islet inflammation cascade is triggered that subsequently destroys pancreatic beta cells causing type 1 diabetes. The pathophysiology of T2D is described as insulin resistance balanced by the hypersecretion of insulin by pancreatic beta cells. Unfortunately, throughout the disease process progression, the beta cells are unable to attain a balance, causing a pathologic state to be present. Inflammation of the pancreatic beta cells increases the number of dysfunctional beta cells. This is predominantly achieved through the activation of a pro-inflammatory state as opposed to anti-inflammatory state in the presence of mediators.

A 2000 study by A. A. Alonzo examined the addition of adverse experiences to an initially identified trauma as an example of the negative implications allosteric load has on chronic illness. Alonzo defines the term “cumulative adversity” as the propagation of physiologic changes like a pro-inflammatory state, more pronounced in increasing instances of adversity, through maladaptive behavior and an incapacity to cope. Additionally, increasing instances of adversities or ACEs predispose individuals to the triggering of PTSD. The prevalence of PTSD and exposure to trauma throughout one’s childhood into adulthood is 40–75%, often occurring with other comorbid conditions [16]. Therefore, it is imperative to identify the role of ACEs and PTSD in the development of adulthood chronic illness in addition to the role chronic illness has itself as a traumatogenic burden that has the ability

to accumulate because of disease trajectory, intrusive or invasive procedures and administrative annoyances.

7. ACEs and implications on international health security

The challenges of chronic disease are evident and encountered not merely by the individual and their support system, but by the healthcare system. The increase in incidence of chronic disease increases direct and indirect healthcare costs that have significant implications on the economy and the ensuing measures to address this problem. It is apparent that adverse childhood experiences (ACEs) considerably contribute to the development of chronic disease as an adult through a higher likelihood of engaging in high-risk, health-harming behaviors, characteristically used as maladaptive coping mechanisms to contest traumatic experiences. It is approximated that 1 billion children, ages 2–17, are anticipated to have encountered an adverse childhood experience as previously described [17]. ACEs are avertible by creating safe and stable childhood settings that encourage less health-harming behaviors used as a strategy to cope with suicidal behavior, substance abuse, etc. [18]. Additionally, stable settings support academic achievement and the possibility to overcome poverty, recognized as a contributor to instances of ACE and perchance an ACE itself.

International health surveillance and initiatives that promote preventative measures on a practitioner level are paramount to address this destructive trend [19]. Said initiatives are beginning to appear in an attempt to address the important implications ACEs have on chronic disease as an adult. Primary and secondary prevention is essential in creating a nonviolent and encouraging environment for children. This includes a surveillance system that is comprehensive, cooperative and effective in identifying vulnerable individuals like a Behavioral Risk Factor Surveillance System (BRFSS). This system provides statistics on ACEs throughout a child's early years. Irrespective of the specific survey utilized, it is important to include trauma-informed practices that possess the empathy essential by primary care practitioners to initiate critical conversations and promote appropriate childhood practices, especially in children that have previously encountered an ACE [20]. It is imperative that individuals that are affected by ACEs be medically managed by clinicians accustomed to their particular health risks and resource for intervention. Initiatives like supplementary feeding programs and targeted food distribution may be initiated in regions where a demonstrated burden of food insecurity including micronutrient deficiency or acute malnutrition is present [21]. In conflict zones, disease prevention including vaccination campaigns, civil protection authorities including legal aid and academic training would be crucial in addressing the detriment of displacement. Tertiary prevention via rehabilitation programs that assist in diminishing high-risk, health-harming behaviors that propagate chronic disease like smoking cessation. Individuals with mental illness like depression, PTSD, etc. need access to appropriate psychiatric management. By enacting these preventative and promotional strategies on a state and national level, it is reasonable to reverse forthcoming projections pertaining to the negative implications of chronic disease on the patient population and healthcare system as an entity.

8. Conclusion

Unfortunately, ACEs are acknowledged to be prevalent and pervasive in society. Slightly under 50% of individuals under the age of 18 admit to an exposure to at

least 1 ACE. An increase in odds ratio for maladaptive, high-risk behavior and morbidities increased as ACE scores increased to 4 or more. Therefore, a strong dose-response relationship exists pertaining to the number of ACEs encountered and the likelihood that health-harming behavior contributes to premature death in individuals diagnosed as having a chronic disease, particularly maladaptive coping mechanisms such as substance abuse and suicidality. Additionally, exposures to ACEs in itself predisposes individuals to chronic disease in their adulthood through proposed mechanisms like the Biological Embedding of Childhood Adversity Model and the negative deterrents of chronic inflammation described as allosteric load [22]. Because of the prevalence and immense impact ACEs have on patient populations and international health including the censorious concepts like conflict, displacement and food insecurity, it is important to implement appropriate intervention and prevention to diminish the prevalence of ACEs in high-risk patient populations.

Author details

Jordan Holter¹, Christine Marchionni¹ and Bankim Bhatt^{2*}

1 Department of Psychiatry, St. Luke's University Health Network, Easton, PA, USA

2 Division of Endocrinology and Metabolism, St Luke's University Health Network, Easton, PA, USA

*Address all correspondence to: bankim.bhatt@sluhn.org

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Bellis MA, Hughes K, Leckenby N, Hardcastle KA, Perkins C, Lowey H. Measuring mortality and the burden of adult disease associated with adverse childhood experiences in England: A national survey. *Journal of Public Health*. 2015;**37**(3):445-454. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4552010/>
- [2] Arredondo A, Aviles R. Costs and epidemiological changes of chronic diseases: implications and challenges for health systems. *PLoS One*. 2015;**10**(3):e0118611. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4364072/>
- [3] The Costs of Chronic Disease in the U.S. The Costs of Chronic Disease in the U.S. Milken Institute. 2018. Available from: milkeninstitute.org/reports/costs-chronic-disease-us
- [4] Crawford C. CDC: Preventing ACEs May Mitigate Chronic Health Issues [Internet]. AAFP Home. American Academy of Family Physicians (AAFP). 2019. Available from: <http://www.aafp.org/news/health-of-the-public/20191113mmwraces.html>
- [5] Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine*. 1998;**14**(4):245-258. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9635069>
- [6] Hughes K, Bellis MA, Hardcastle KA, Sethi D, Butchart A, Mikton C, et al. The effect of multiple adverse childhood experiences on health: A systematic review and meta-analysis. *The Lancet*. 2017;**2**(8):e356-e366. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/29253477>
- [7] Chang X, Jiang X, Mkandarwire T, Shen M. Associations between adverse childhood experiences and health outcomes in adults aged 18-59 years. *PLoS One*. 2019;**14**(2):e0211850. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6366931/>
- [8] Food Security and Nutrition Assistance. USDA ERS - Food Security and Nutrition Assistance. 2019. Available from: <https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance/>
- [9] Reed RV, Fazel M, Jones L, Panter-Brick C, Stein A. Mental health of displaced and refugee children resettled in low-income and middle-income countries: Risk and protective factors. *The Lancet*. 2011;**379**(9812):250-265. Available from: <https://www.sciencedirect.com/science/article/pii/S0140673611600500>
- [10] McEniry M, Samper-Ternent R, Flórez CE, Cano-Gutierrez C. Early life displacement due to armed conflict and violence, early nutrition, and older adult hypertension, diabetes, and obesity in the middle-income country of Colombia. *Journal of Aging and Health*. 2019;**31**(8):1479-1502. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/29916766>
- [11] Calam R. Public health implications and risks for children and families resettled after exposure to armed conflict and displacement – Rachel Calam. *SAGE Journals*. 2017, 2016;**45**(3):209-211. Available from: <https://journals.sagepub.com/doi/10.1177/1403494816675776>
- [12] Berens AE, Jensen SKG, Nelson CA. Biological embedding of childhood adversity: from physiological mechanisms to clinical implications. *BMC Medicine*. 2017;**15**(1):135.

Available from: <http://www.ncbi.nlm.nih.gov/pubmed/28724431>

[13] Danese A. Adverse childhood experiences, allostasis, allostatic load, and age-related disease: Request PDF. ResearchGate. 2011;106(1):29-39. Available from: https://www.researchgate.net/publication/51616220_Adverse_childhood_experiences_allostasis_allostatic_load_and_Age-related_disease

[14] Su S, Jimenez MP, Roberts CTF, Loucks EB. The role of adverse childhood experiences in cardiovascular disease risk: A review with emphasis on plausible mechanisms. *Current Cardiology Reports*. 2015;17(10):88. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4941633/>

[15] Tsalamandris S, Antonopoulos AS, Oikonomou E, Papamikroulis G-A, Vogiatzi G, Papaioannou S, et al. The role of inflammation in diabetes: Current concepts and future perspectives. *European Cardiology*. 2019;14(1):50-59. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6523054/>

[16] Alonzo A. The experience of chronic illness and post-traumatic stress disorder: The consequences of cumulative adversity. *Social Science & Medicine*. 1982;50(10):1475-1484. Available from: <https://pubmed.ncbi.nlm.nih.gov/10741582/>

[17] Wyckoff AS. Preventing ACEs has potential to reduce leading causes of death in adults: Study. *American Academy of Pediatrics*. 2020. Available from: <http://www.aappublications.org/news/2019/11/05/aces11519>

[18] Dube SR, Anda RF, Felitti VJ, Chapman DP, Williamson DF, Giles WH. Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span:

Findings from the adverse childhood experiences study. *JAMA*. 2001;286(24):3089-3096. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/11754674>

[19] Jones CM, Merrick MT, Houry DE. Identifying and preventing adverse childhood experiences: Implications for clinical practice. *JAMA*. 2019. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/31689343>

[20] Shenoda S, Kadir A, Pitterman S, Goldhagen J, Health SOIC. The effects of armed conflict on children. *American Academy of Pediatrics*. 2018;142(6):e20182585. Available from: <https://pediatrics.aappublications.org/content/142/6/e20182585>

[21] Chanlongbutra A, Singh GK, Mueller CD. Adverse childhood experiences, health-related quality of life, and chronic disease risks in rural areas of the United States. *Journal of Environmental and Public Health*. 2018. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6077617/>

[22] Lopez-Candales A, Hernández Burgos PM, Hernandez-Suarez DF, Harris D. Linking chronic inflammation with cardiovascular disease: From normal aging to the metabolic syndrome. *Journal of Nature and Science*. 2017;3(4):e341. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5488800/>

Nurturing Responsible Future Generation of Scientists: Focus on Maintaining International Health Security Competency

Aroem Naroeni and Budiman Bela

Abstract

Rapid progress of technologies does not only exclusively belong to developed countries nowadays but also spread out to developing countries including Indonesia. There are many Indonesian universities and emerging translational medicine centers that had declared themselves as research centers focusing on to bring science from bench to bedside. Since the outbreak of 2007 Avian Influenza, Indonesia had been starting to accumulate more knowledge and experiences related to biosafety and biosecurity. While Indonesian researchers were focusing on biorisk management of high pathogenic bioagents, students were also being exposed gradually to more sophisticated biological hazards through the utilization of synthetic biology and genetic modifications on their own researches. Nurturing the responsible future generation of scientist whom aware of the ethical, biosafety, biosecurity concerns cannot become more important, considering the possibility of dual use research results, which could bring either prosperity or chaos to the universe.

Keywords: biosafety, biosecurity, dual use research of concern

1. Introduction

Since the outbreak of 2007 Avian Influenza, Indonesia had been starting to accumulate more knowledge and experiences related to biosafety and biosecurity. While Indonesian researchers were focusing on biorisk management of high pathogenic bioagents, students were also being exposed gradually to more sophisticated biological hazards through the utilization of synthetic biology and genetic modifications on their own researches.

Trainings and workshops on aforementioned issues had been organized regularly, and at the same time, High Containment Facilities as BSL3 had been built in some locations with supports from various International organizations such as BEP, WHO, and FAO. One of the projects is the establishment and evaluation of Biorisk Management in University of Indonesia [1].

In 2005, WHO has established International Health Regulation (IHR) to strengthen health security, which defined as “activities required to minimize the danger and impact of acute public health events that endanger the collective health and population living across geographical regions and International boundaries.”

IHR has purpose to provide swift response to global threats of spread of diseases without imposing significant disturbance to international traffic and trade [2]. One of implementations of IHR was by establishment of Global Health Security Agenda (GHSA) consortium to give participant countries such as Indonesia a capacity to prevent, detect, and respond to this spread, regardless of the root causes such as natural, deliberate, or accidental occurrences.

To achieve these goals, GHSA developed concept called “Action Packages,” where Biosafety and Biosecurity are important elements. This Action Packages consist of:

- Prevent 1: Antimicrobial Resistance
- Prevent 2: Zoonotic Disease
- Prevent 3: Biosafety and Biosecurity
- Prevent 4: Immunization
- Detect 1: National Laboratory System
- Detects 2 and 3: Real-Time Surveillance
- Detect 4: Reporting
- Detect 5: Workforce Development
- Respond 1: Emergency Operation Centers
- Respond 2: Linking Public Health with Law and Multisectoral Rapid Response
- Respond 3: Medical Countermeasures and Personnel Deployment Action Package [3].

A country achievement to GHSA Active Pack implementation is assessed voluntarily by a Joint External Evaluation (JEE). Indonesia was assessed back in 2017 by JEE with several recommendations:

1. to formulate necessary regulations to allow development and integration of IHR in a country multisectoral level;
2. to define a coordination mechanism between IHR and global security task force with relevant local ministries, agents, and institution; and
3. to evaluate and simplify bureaucratic structure of decision makers to enable Indonesia to act fast to national and international issues.

The report also noted the absence of National Biosafety and Biosecurity manual and the absence of select agent list and National Inventory of Biological agent [4, 5].

One Health University Network and One Health Laboratory Network were established to promote Biorisk Management at university level, which was participated by Indonesian well-known university such as Gadjah Mada University, Airlangga University, and Syiah Kuala University with pilot project at their own medical and veterinary labs. Major outcomes from this project were the establishment of institutional biosafety committee, a certification program for professional biorisk management, and the development of laboratory assessment tools.

In National scope, Indonesian Biosafety Association was founded in 2011 with objectives to:

- build a proper capacity in biorisk management in laboratories in Indonesia (research institutions, diagnostics, industry, and hospitals);
- collaborate with government and other authorities by providing technical inputs for national strategies, policies, and guidelines on biorisk management as well as advocate for a better understanding of biorisk management itself;

- become an efficient, functional, and sustainable biosafety organization;
- build interaction and communication between scientists and nonscientist professionals in order to support the development of biorisk in Indonesia;
- provide a forum to represent the interests and needs of biorisk practitioners, as well as a source for continuous information updates; and
- conduct training to ensure the implementation of safe laboratory quality and standards that are carrying out according to principles of biorisk management [6].

In addition, Biorisk Management standard had been successfully formulated under Indonesian National standard (SNI) nos. 8340:2016 and 8434:2017, which was adopted from CWA 15793 and CWA 16393, respectively [7–10].

At this report, we are focusing on the following areas:

- select agents and risk group;
- emerging and reemerging disease researches; and
- researches that use emerging technologies in Indonesia.

2. Methods

References from National and International Biorisk Management Guidelines in health, education, veterinary, and agriculture areas in various countries were sought to provide an in-depth view on this matter. It is noted that scientific journals on biorisk management and responsible science are still limited; therefore, some sources could only be obtained from unpublished reports and webpages.

3. Defining select agents and risk group in Indonesia

Definition of select agent according to the US Centers for Disease Control and Prevention (CDC) is “biological agent and toxins determined to have the potential to pose a severe threat to public health and safety to animal and plant health or to animal or plant products.”

There are 67 organisms in CDC’s list agents, which developed from initial list which contained 42 agents and toxins introduced in 1997. It included some agents that could affect both humans and animals (for example, *Bacillus anthracis* and *Francisella tularensis*) but not those whom affecting animals and plants only. It was preceded by some events such as:

- international commitments not to use disease as a weapon are embodied in the Geneva Protocol, which was signed in 1925 and entered into force in 1928. This protocol prohibited the usage of chemical and biological as weapons; however, it did not band the production, storage, or transfer of those materials and
- the Biological and Toxin Weapons Convention (BWC), which was signed in 1972 and entered into force in 1975 as well as Chemical Weapons Convention in 1993. This closed the gap, which was not covered by Geneva Protocol previously.

Article I of the BWC states that “Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

1. Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;
2. Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.”

Group	WHO [18]	NIH [19]	EU [13]	China [20]
1	Well-characterized agents are likely not cause human or animal disease.	Agents are not associated with disease in healthy adult humans.	Agents are unlikely cause human disease.	Agents do not cause human or animal disease under normal circumstances.
2	Agents cause human or animal disease but unlikely to be a serious hazard to laboratory workers, the community, the livestock, or the environment. Effective treatment and preventive measure are available.	Agents are associated with human disease, which is rarely serious. Effective treatment and preventive measure are often available.	Agents can cause human disease and might be a hazard to workers. It is unlikely to spread to the community. Effective prophylaxis or treatment is usually available.	Agents cause human or animal disease under normal circumstances but do not pose a serious hazard to people, animals, or the environment, and the risk of transmission is limited. Laboratory-associated infection rarely causes serious illness with effective treatment and prevention.
3	Agents usually cause serious human or animal disease but do not spread from one individual to another. Effective treatment and preventive measures are available.	Agents are associated with serious or lethal human disease. Preventive or therapeutic interventions may be available. Risk of spreading to individual is high but to community is low.	Agents can cause severe disease and pose a serious hazard to workers. It may spread to community, but effective prophylaxis or treatment is usually available.	Agents can cause serious human or animal disease. It is relatively easy to spread between people, animals and people, among animals, directly or indirectly.
4	Agents usually cause serious human or animal disease. They can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.	Agents likely cause serious or lethal human disease. Preventive or therapeutic interventions are not usually available. Risk of spreading to individual and to community is high.	Agents cause severe human disease and pose a serious hazard to workers. Risk of spreading to community is high. Effective prophylaxis or treatment is usually not available.	Agents can cause very serious disease in humans and animals, including biological agents that have not been found in China.

Table 1.
Comparison of biological agent category criterion based on biosafety.

The BWC does not prohibit research on defenses against biological weapons where a number of countries, including the USA and its major allies, have continued to do. Indonesia signed the BWC in 1972 and signed the ratification in 1992. Currently, there are 183 countries that have ratified BWC [11].

In developed countries such as the USA, Europe, Canada, China, and Singapore, select agents have been defined well, but most of the developing countries including Indonesia do not have it yet [12–16]. Resources of biological agents in developing countries are very significant; thus with the presence of various biological agents and toxins, it can cause a real threat. Some countries can refer to the biological agent list of the US CDC, but this is not a universal list because it may contain some preferences to the US national interest. Developing countries should evaluate characteristics of each biological agent and threats faced, existing biodefense capabilities based on its specific regional conditions. The CDCs of developing country play an important role in this process and cooperate with other related departments and organizations [17]. Although some US organizations had facilitated discussion with relevant Indonesian institution and initiate list of select agents but the list could not be defined yet. Indonesian Ministry of Agriculture has “red microorganisms,” where the usage and distribution must be limited to certain laboratories; however, it is not a standard practice for others. Nowadays, there is no select agent list in Indonesia. Controlling the work of using these pathogens and high pathogenic organisms has been performed by each institution individually. Most of laboratories do not have the awareness about the importance to limit the usage of select agents. Furthermore, Indonesia also does not have risk group category criterion. WHO or CDC criteria were followed, which sometimes may not be suitable with local condition (Table 1).

4. Emerging and reemerging infectious diseases

Other important subjects are emerging and reemerging infectious diseases, which could pose a major threat to global public health. On the other hand, these subjects also attract many scientists to obtain good publications and funding. Despite of all efforts in biorisk management, unfortunately the handling of pathogenic viruses remains a likely source of infection, and mortality, among laboratory workers [21].

Accidental infections of workers in hospitals or research laboratories are an emerging threat mainly due to the increasing amount of research with it being

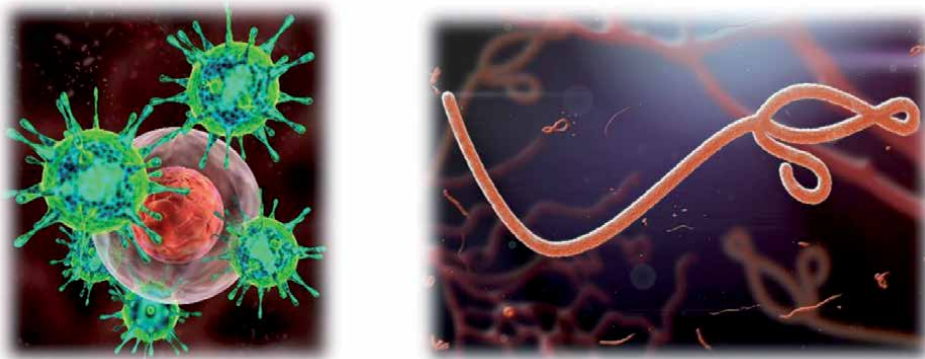


Figure 1.
Hepatitis and Ebola virus.

carried out involving the Risk Group 3 or 4 [22]. Infections due to the blood borne emerging viruses such as hepatitis C and HIV are the commonest diagnosed viral infections [23]. Laboratory-acquired infection by other emerging viruses such as SARS, Marburg, dengue, vaccinia, Crimean-Congo hemorrhagic fever, Western equine encephalitis, West Nile virus, and Zika has also been reported [24–30].

A strict biorisk assessment should be applied prior to experiments. A sufficient mitigation should be assessed by biosafety officer and Biosafety committee. Unfortunately, only some institutions in Indonesia have Institutional Biosafety Committee and do not have National Biosafety Committee yet. Currently, assessment was performed together, and decision was made based on available mitigation in the laboratory (**Figure 1**).

5. Emerging technologies

Rapid progress of technologies does not only exclusively belong to developed countries nowadays but also spread out to developing countries including Indonesia. Life sciences such as molecular biology, bioengineering, genetic engineering, bioinformatics, and synthetic biology could not be more important nowadays since it plays a pivot role in developing translational medicines and biotechnologies. There are many Indonesian universities and emerging translational medical centers that had declared themselves as research centers focusing on to bring science from bench to bedside. Also, many biotechnology centers provide sources for livestock, pharmacy, cosmetics, industry, and many more. They always try to bring experiments to applications.

On the other hand, the development in life science is no longer obtained exclusively through formal educations but could also be acquired from powerful informal sources such as Internet and social network. Without a proper guidance, biosafety, biosecurity, and dual use issues can become a major risk in human life itself. It could be said that biosafety focuses on procedures and techniques to prevent an accidental or unintentional release of bioagents, and biosecurity focuses more on accountability measurements and procedures to protect bioagents from unauthorized access, misused, thievery act of an intentional release [9, 31, 32]. Dual use according to the US Government is “a life sciences research that, based on current understanding, can be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, materiel, or national security.” The US Government’s oversight of DURC is aimed at preserving the benefits of life science research while minimizing the risk of misuse of the knowledge, information, products, or technologies provided by such research. Whereas WHO’s definition is “life sciences research that is intended for benefit, but which might easily be misapplied to do harm.”

During this time, we also met with students whom very interested in participating on International Genetically Engineered Machine (IGEM), where Indonesia is an active participant since 2013. On one of IGEM project on TBC diagnostic system called “Blue Ivy Project,” it brought us to important realization regarding dealing with the amplification of risk in growing cultures and biofilm where rigorous SOPs during works were required to satisfy its biosafety and biosecurity aspect of this project (**Figure 2**) [33].

Challenges in biosafety and biosecurity became more complicated year by year such as “BaContraception Project” to design contraception by using *Bacillus subtilis 168a* and *Escherichia coli BL21* to express SboA—the spermicidal protein and



Figure 2.
IGEM project in University of Indonesia.

ndoA—the suicide protein, where researchers were exposed to risk of sterility. The lessons learnt from this project were “who create risk will be the responsible person to manage the risk” and realization of no official bodies in Indonesia handling synthetic biology domain [34].

In the next project, the Hi Vax project, we knew that Indonesia got attention from the IGEM board as we got information from FBI during its workshop in Jakarta. They would like to make us aware that technologies are progressing fast in Indonesia and urge a control going along it to not cause harm and threats. Hi Vax project is a project to make HIV DNA Vaccine. Basically, they are capable of making the HIV proteins with this system. It is why FBI emphasized this issue to all stakeholders in Indonesia to have concerns about the science progress in Indonesia and think about the risk particularly dual use research of concerns along the progress of technologies. In addition, in the recent IGEM project which working with the synthetic toxin of Diphtheria, team started to establish carefully the risk assessment, so they are capable of analyzing the possibility of dual use research and communicating it to IGEM’s Biosafety and Biosecurity Board [35].

Based on our experiment, we realize the urgent of need of National Biosafety Committee or at least Institutional Biosafety Review Board. But, how many lectures or researchers have concern about this? Whereas many new emerging technologies are coming with fast progressing to arrive in the border of ethical problems and of course, the biosafety, biosecurity, and dual use research of concern. Recombinant protein, Genetically Modified Organisms, induced-Pluripotent Stem Cell (iPS), Gain of Function (GoF), and CRISPR (clusters of regularly interspaced short palindromic repeats) are now coming and become a common methods at life science laboratories. In addition, DIY-bio (Do it Your self Biology) is omnipresent at the same time of the emerging of biotechnology program and biotechnology start up. They must be equipped with a sufficient Biorisk Management. Recombinant protein is a technology to produce protein made based on DNA recombinant that has been cloned in system that supports expression of the gene. Modification of gene by using recombinant technology leads to the expression of a mutant protein, over expression or suppress expression. Gain of Function (GoF) is a research that involves experimentation that aims or is expected to (and/or, perhaps, actually does) increase the transmissibility and/or virulence of pathogens. The aim of GOF research is to improve understanding of disease causing agents, their interaction with human hosts, and/or their potential to cause pandemics. GOF research (GOFr) can pose risks regarding biosecurity and biosafety. Nowadays, new technologies that become a star are CRISPR and iPS. CRISPR or CRISPR Cas 9 system allows genetic material to be added, removed, or altered at particular locations in the genome, whereas iPS allows whatever cells in the body to be reprogram into

stem cells. These future technologies are expected to resolve many problems in disease therapies, and at the same time, we have to minimize the side effects of these technologies.

6. Responsible science

The advance of biotechnology benefits for life science research. It resulted in important biomedical products and resolved many health problems. However, advances in technology and research can unintentionally lead to techniques and/or findings that:

- increase virulence, transmission, or host range of a pathogen;
- confer antibiotic resistance so as to decrease currently effective treatments;
- enable evasion of currently existing diagnostic or detection mechanisms; and
- demonstrate weaponization of a pathogen.

WHO created guideline Responsible life science research for global health security for promoting excellent, safe, secure and responsible life science research. It consists of three pillars supporting public health:

- research excellence;
- ethics; and
- biosafety and laboratory biosecurity.

This guideline shows that the best protection against the possibility of accidents and deliberate misuse of life science can be attained by promoting culture of scientific integrity and excellence and distinguished by openness, honesty, accountability, and responsibility (**Figure 3**).

Research excellence means encouraging quality of life science activities that serve as the basis of development of new treatments and therapeutics. It supports health research system and promotes public health surveillance and response activities. These all elements are essential to protect and improve health and well-being of all people. To attain them, countries or institutions are requested to:

- support capacity development for research and
- use existing tools and frameworks, which are health research systems (HRS), the WHO strategy on research for health, and the International Health Regulations (IHR) as these can provide useful tools for contributing to responsible life science research.

Ethics are promoting responsible and good research practices. It provides tools and practices to scientists and institutions that allow them to discuss, analyze, and resolve dilemmas they may face in research including problem related to the possibility of accidents or misuse of the life sciences. Countries and institutions are requested to:

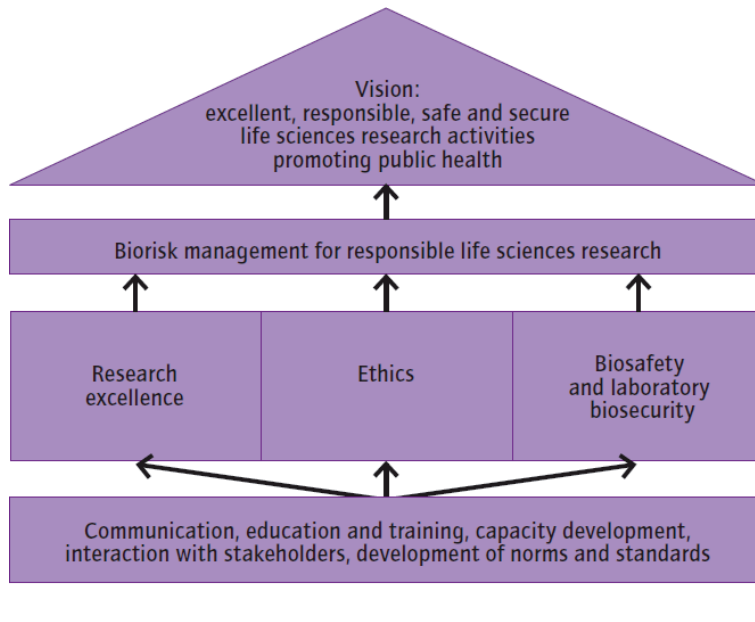


Figure 3.
Biorisk management framework for responsible life science research.

- use current ethical platforms, if appropriate;
- promote ethics education and training for students and professionals;
- encourage discussion and reflection on research practices;
- hold institutions and researchers to account and ensure they are aware of their responsibilities; and
- ensure institutions and researchers are aware of existing and new legislation, regulations not only at the country but also at the regional and international levels.

Biosafety and biosecurity are the implementation and strengthening of measures and procedures to:

- minimize the risk of worker exposure to pathogens and infections;
- protect the environment and the community; and
- protect, control, and account for valuable biological materials (VBMs).

All measures are applied in the laboratory or institution in order to prevent accidental and deliberate release of pathogens and valuable biological materials. They are aimed to ensure a safe and secure laboratory environment. Countries and institutions are requested to:

- conduct biosafety and laboratory biosecurity risk assessments and prepare mitigations to reduce the risk;

- implement a laboratory biorisk management system;
- explore the use of existing biorisk management structures (e.g., laboratory biorisk management adviser and the biosafety committee) to address issues related to the risks posed by life science research; and
- set performance objectives and work on continuous improvement [36].

7. Recommendation and lesson learned

The progress of biotechnologies in developing countries especially in Indonesia does not walk in parallel with the raising of awareness for more responsible science, which gives an alert for future development on life science research itself. Thus, a task to raise awareness for more responsible science should be done in all sectors particularly in universities and research centers. In addition, responsible science must reach young scientists and spread at all universities in Indonesia.

Although Indonesia had established national standards for biorisk management, yet they are still on voluntary basis and not implemented in all related institutions. Thus, establishment of more detail guidelines and compulsory regulations on biorisk management should be accelerated and performed by all stakeholders.

8. Conclusion

University medical research center is one of a front line to face emerging technologies and emerging diseases. It is a place that could bring a silver lining in developing health security, but at the same time, it could pose a concern on dual use research application.

Medical research center is a good place to start applying more responsible science and nurturing the next generation of scientists whom have more awareness on biorisk issues. However, it is still long way to go at least for Indonesia to establish the biosafety committee at institutions as well as at national level. A need to define National Select Agents and Risk group microorganisms is also noted to provide guideline and better support for biorisk management itself.

Regardless all limitations above, efforts to raise awareness in young scientists should continue not only by established organizations such as Indonesian Biorisk Association and One Health Laboratories Network but also by full supports from other relevant stakeholders in order to motivate them to create a better research environment.

Acknowledgements

We thank Indonesian Biorisk Association and One Health Laboratories Networking for the additional information. We would also like to thank Hendri Bundrawan for manuscript preparation, English correction, and editing.

Author details

Aroem Naroeni^{1,2*} and Budiman Bela^{1,2,3}

1 Virology and Cancer Pathobiology Research Center, Medical Faculty, Universitas Indonesia, Jakarta, Indonesia

2 Cipto Mangunkusumo National Hospital, Jakarta, Indonesia

3 Department of Microbiology, Medical Faculty, Universitas Indonesia, Indonesia

*Address all correspondence to: aroem.naroeni@gmail.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Naroeni A, Bachtiar EW, Ibrahim F, Bela B, Kusminanti Y, Pujiriani I, et al. Challenges in implementing a biorisk management program at Universitas Indonesia: A checklist tool for biorisk management. *Health Security*. 2016;**14**(6). DOI: 10.1089/hs.2016.001
- [2] WHO. International Health Regulation. 2005. Available from: <http://apps.who.int/iris/rest/bitstream/1031116/retrieve> [Accessed: 18 August 2019]
- [3] GHSA. Action Package. 2014. Available from: https://www.cdc.gov/globalhealth/security/pdf/-ghsa-action-packages_24-september-2014.pdf
- [4] GHSA. Country Assessment Tool. 2015 Available from: <https://www.ghsagenda.org/-assessments>. [Accessed: 18 August 2019]
- [5] Ministry of Health Republic of Indonesia. 2017. Joint External Evaluation (JEE) Report.
- [6] Indonesian Biorisk Association. Available from: <https://indonesianbioriskassociation.org/>
- [7] Badan Standarisasi Nasional. SNI 8340:2016 Sistem Manajemen Biorisiko Laboratorium. 2016
- [8] Badan Standarisasi Nasional. SNI 8434:2017. Panduan Pelaksanaan Sistem Manajemen Biorisiko. 2017
- [9] Comité Européen de Normalisation. CEN Workshop Agreement. CWA 15793. Laboratory Biorisk Management. 2011. Available from: http://www.uab.cat/doc/CWA15793_2011 [Accessed: 28 September 2016]
- [10] Comité Européen de Normalisation. CEN Workshop Agreement. CWA 16393. Laboratory biorisk management—Guidelines for the implementation of CWA 15793:2008. Available from: <https://www.cdc.gov.tw/Uploads/files/201504/d0feebf2-a92c-46e1-914a-b9d1435bc52f.pdf> [Accessed: 23 September 2016]
- [11] National Research Council. Responsible Research with Biological Select Agents and Toxins. Washington, DC: The National Academies Press; 2009. DOI: 10.17226/12774
- [12] List of human and animal pathogens and toxins for export control. Available from: http://www.australiagroup.net/en/human_animal_pathogens.html [Accessed: 18 August 2019]
- [13] Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000. Available from: <http://osha.europa.eu/en/legislation/directives/exposure-to-biological-agents/77> [Accessed: 18 August 2019]
- [14] List of human transmission of pathogenic micro-organisms. 2006. Available from: <http://www.chinacdc.net.cn/n272442/n272530/n275462/n275477/n292895/11276.html> [Accessed: 18 August 2019]
- [15] Available from: <https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/human-pathogens-toxins-act/security-sensitive-biological-agents.html> [Accessed: 18 August 2019]
- [16] Available from: <https://www.moh.gov.sg/biosafety/about-bata> [Accessed: 18 August 2019]
- [17] Tian D, Zheng T. Comparison and analysis of biological agent category lists based on biosafety and biodefense. *PLoS One*. 2014, 2014;**9**(6):e101163. DOI: 10.1371/journal.pone.0101163

- [18] World Health Organization. Laboratory Biosafety Manual. 3rd ed. 2004. Available from: <http://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf> [Accessed: 18 August 2019]
- [19] NIH Guidelines For Research Involving Recombinant DNA Molecules (October 2011, Revised Edition). Available from: http://oba.od.nih.gov/rdna/nih_guidelines_oba.html [Accessed: 18 August 2019]
- [20] Pathogenic microbiology laboratory bio-safety regulations. 2004. Available from: http://www.gov.cn/fwxx/bw/nyb/content_375877.htm [Accessed: 18 August 2019]
- [21] Artika M, Ma'roef CN. Laboratory biosafety for handling emerging viruses. *Asian Pacific Journal of Tropical Biomedicine*. 2017;7(5):483-491
- [22] Pedrosa PBS, Cardoso TAO. Viral infections in workers in hospital and research laboratory settings: A comparative review of infection modes and respective biosafety aspects. *International Journal of Infectious Diseases*. 2011;15:e366-e376
- [23] Singh K. Laboratory-acquired infections. *Healthcare Epidemiology*. 2009;49:142-147
- [24] Britton S, van den Hurk AF, Simmons RJ, Pyke AT, Northill JA, McCarthy J, et al. Laboratory-acquired dengue virus infection—A case report. *PLoS Neglected Tropical Diseases*. 2011;5:1-3
- [25] Lewis FMT, Chernak E, Goldman E, Li Y, Karem K, Damon IK, et al. Ocular vaccinia infection in laboratory worker, Philadelphia, 2004. *Emerging Infectious Diseases*. 2006;12:134-137
- [26] Hsu CH, Farland J, Winters T, Gunn J, Caron D, Evans J, et al. Laboratory-acquired vaccinia virus infection in a recently immunized person—Massachusetts, 2013. *Morbidity and Mortality Weekly Report*. 2015;64:435-438
- [27] Günther S, Feldmann H, Geisbert TW, Hensley LE, Rollin PE, Nichol ST, et al. Management of accidental exposure to Ebola virus in the biosafety level 4 laboratory, Hamburg, Germany. *The Journal of Infectious Diseases*. 2011;204:S785-S790
- [28] Campbell G, Lanciotti R. Laboratory-acquired West Nile virus infections—United States, 2002. *Morbidity and Mortality Weekly Report*. 2002;51:1133-1135
- [29] Wong SS, Poon RW, Wong SC. Zika virus infection—The next wave after dengue? *Journal of the Formosan Medical Association*. 2016;115:226-242
- [30] US News. Zika Virus: Laboratory Acquired Case Reported in Pittsburgh Area. USA; June 9, 2016
- [31] World Health Organization. Laboratory Biosafety Manual. 3rd ed. Geneva: WHO; 2004. Available from: http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_CSR_LYO_2004_11/en/. [Accessed: 18 August 2019]
- [32] World Health Organization. Biorisk Management: Laboratory Biosecurity Guidance. Geneva: WHO; 2006. Available from: http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006_6.pdf [Accessed: 18 August 2019]
- [33] IGEM. Blu Ivy project. 2014. Available from: <http://2014.igem.org/Team:UI-Indonesia> [Accessed: 18 August 2019]
- [34] IGEM. BaContraception project. 2015. Available from: http://2015.igem.org/Main_Page [Accessed: 18 August 2019]

[35] IGEM. The Hi Vax project. 2016.
Available from: [http://2016.igem.org/
Main_Page](http://2016.igem.org/Main_Page) [Accessed: 18 August 2019]

[36] World Health Organization.
Responsible life sciences research for
global health security. A guidance
document. 2010. Available from:
[https://www.who.int/csr/resources/
publications/ HSE_GAR_BDP_2010_2/
en/](https://www.who.int/csr/resources/publications/HSE_GAR_BDP_2010_2/en/) [Accessed: 18 August 2019]

mHealth-Based Microfluidic Lab-on-a-Chip for International Health Security

Mirza Abdul Aleem Baig

Abstract

The increasing threats of emerging and reemerging infectious disease outbreaks demand research and development (R&D) of effective and fit-for-all-purpose tools and technologies for international public health security. Recent advances in biomedical engineering, mostly related to the convergence of communication and network technology in health, i.e., mobile health with microfluidic Lab-on-a-Chip technology can improve the international public health crises and employ in international public health security. Lab-on-a-Chip technology is now commonly found in most research centers, hospitals, and clinics where health care infrastructure is weak, and access to quality and timely medical care is challenging. Microfluidic devices—also known as Lab-on-a-Chip (LoC)—are an alternative for accessible, cost-effective, and early detection medical trials. The mHealth-based microfluidic LoC technology has been under rapid development, and they are becoming influential tools in a wide range of biomedical research and international public health applications. The perspective in this chapter demonstrates a potentially transformative opportunity for the deployment of mHealth with LoC with the fabrication protocols and their potential for strengthening and improving the international public health security. This attempt is not conclusive and exhaustive, and it is anticipated that such a discussion will enable the exchange of ideas between biomedical engineering, microfluidic LoC technology professionals, international public health, and health security experts.

Keywords: biomedical engineering, mobile health (mHealth), microfluidic, Lab-on-a-Chip, international public health security

1. Introduction

Emerging and reemerging infectious diseases, and their pandemic potential, pose a challenge to international public health security in the twenty-first century that cannot be overlooked [1]. Though the historical threat to international security by epidemic diseases is not new, the threat has increased in recent years and is growing rapidly. Infectious disease emergencies can arise with little notice and have serious detrimental and lasting effects on international public health security [2]. In the past century, we have seen international health emergencies such as the 1981 influenza pandemic that killed approximately 50–100 million people [3], the

emergence of the deadly SARS coronavirus, and the 2013–2016 Ebola epidemic in West Africa [4] that resulted in more than 28,000 cases and 11,000 deaths and had devastating impacts on international health security, as just a few exemplar. Correspondingly, before 1970, only nine countries had experienced severe dengue epidemics; however, at present, dengue fever has affected more than 100 countries in tropical and subtropical regions [5]. It was estimated by the World Health Organization (WHO) that approximately 150 million dengue infections occur annually, with a 30-fold increase in global incidence observed over the past 50 years [6]. Reemergence of mosquito-borne infections such as chikungunya, zika, more virulent forms of malaria, and new more severe forms of viral respiratory infections has also evolved in recent years. Historically, literature on health and security has been scarce, and only in the past few years, a body of literature on health and security emerged. At the nexus of health and security lies many poignant examples of the growing threat of biological weapons, the negative impact of naturally occurring infectious diseases, and the migration and proliferation of emerging and reemerging infectious diseases to nonendemic areas that fabricate a strong case for including health concerns in the international public health security debate. Though international public health and health security traditionally occupied separate domains, in recent years, the imperative fusion between them has been recognized by policymakers and security and defense analysts in both developed and developing countries [7].

1.1 International public health security

International public health security is pretty new topic, and it has recently taken on a new urgency for policymakers and health security and defense analysts. The field of international public health security is an important one, closely related to people's lives, and essential for societies and countries to grow and develop. Traditionally, environmental health emergencies, humanitarian emergencies including natural and human-made disasters, conflicts and complex emergencies, civil strife, or human health rights violations constitute what has been considered the main threat to health security [8, 9]. Correspondingly, pandemics and epidemics also killed countless millions throughout human history. The 1918 flu pandemic killed 50–100 million, which is more than the combined total casualties of World War I and II [10]. In our time, highly virulent infectious diseases have not only repeatedly swept through human societies, causing death, economic chaos, and political and social disorders, but also placed sudden and intense demands on international public health security. In many countries, millions of people are suffering from avoidable health problems. Improvements to health and medical services are therefore emerging as a major priority in many countries, where many people continue to suffer due to common diseases such as HIV/AIDS, diabetes, and cancer, including tropical diseases, such as malaria, dengue fever, respiratory diseases, etc. [11]. Today, such diseases remain a serious international public health threat. According to the world health report released by the World Health Organization (WHO), noncommunicable diseases (NCDs) are responsible for approximately 71% of global deaths, with the leading causes being lower respiratory infections, HIV/AIDS, diarrheal diseases, and tuberculosis (TB) [12]. **Table 1** illustrates the top 10 leading causes of death in three categories, i.e., worldwide, low-income countries, and high-income countries. Many diseases need immediate attention and require new health technologies for their prevention and on-time diagnosis. One such promising solution can now be thought of because of the recent advances in the mobile health (mHealth) and Lab-on-a-Chip (LoC) technologies. On-going

Rank	Worldwide	Low-income countries	High-income countries
1	Heart disease	Lower respiratory infections	Heart disease
2	Stroke	Diarrheal diseases	Stroke
3	Chronic obstructive pulmonary disease	Heart disease	Alzheimer's disease
4	Lower respiratory infections	HIV/AIDS	Lung cancers
5	Alzheimer's disease	Stroke	Chronic obstructive pulmonary disease
6	Lung cancers	Malaria	Lower respiratory infections
7	Diabetes	Tuberculosis	Colon caners
8	Road injury	Preterm birth complications	Diabetes
9	Diarrheal diseases	Birth asphyxia and trauma	Kidney diseases
10	Tuberculosis	Road injury	Breast caner

Table 1.
The top 10 leading causes of death [12].

research in these technological fields leads to the rapid emergence of such devices that can prove to be very useful for improving the international public health and employed in health security.

1.2 Mobile health (mHealth)

mHealth is defined as the use of mobile communication and network technologies, i.e., smartphones, tablet PCs, and PDAs, for health service [13]. In broad, it is the employ of handy gadgets that are having ability of improving health and quality of care. mHealth is an evolving and swiftly rising field that holds the potential to play an imperative part in the transformation of healthcare and increase the quality of care. mHealth cover a range of hi-tech solutions, such as measure of vital signs, i.e., heart beating rate, blood sugar level, blood pressure, temperature of body, activities of brain, etc. [14]. The widespread use of mobile devices has offered a novel approach to address many health-related challenges. The mobile devices and mobile networks can be present in resource-limited regions where medical equipments are either unavailable or insufficiently portable for wide deployment. According to the data released by International Telecommunication Union (ITU), 96.8% of the people worldwide are mobile-cellular telephone subscribers, and 62.9% of them are active mobile-broadband users [15, 16]. The statistic in **Figure 1** shows the total number of mobile phone users worldwide from 2015 to 2020. In 2019, the number of mobile phone users was forecast to reach 4.68 billion [17]. The penetration of mobile devices in many regions has surpassed many other infrastructures, i.e., electricity, paved roads, and advanced healthcare resources. Such increasing accessibility of mobile devices can provide opportunities to transform the international public health and health security.

Smartphones have been increasingly adapted in various healthcare applications in recent years [18], and according to applications, the use of mHealth-based healthcare practice can be divided into two categories, as demonstrated in **Table 2** in vivo test and in vitro test. Similarly, out-of-clinic smartphone use covers most of the software applications and the corresponding devices, external wearable sensors, for the daily monitoring of the health and wellness. On the other hand,

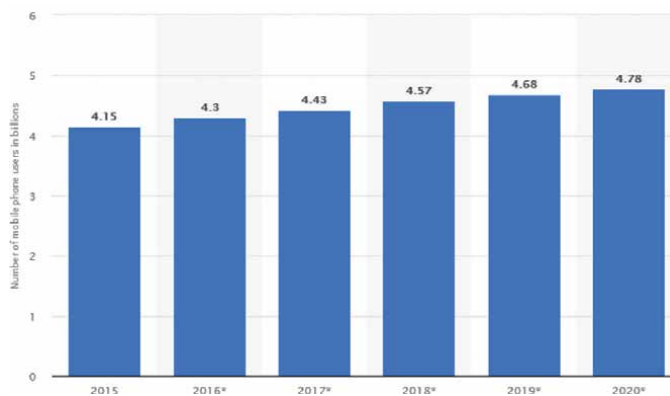


Figure 1.
The number of mobile phone users worldwide from 2015 to 2020 [17].

Category	Explanation	Examples	
In vivo test	Test that does not require sample consumption; biological signals are converted to electrical signals by various sensors.	Test with built-in sensor	Use the built-in sensors, such as camera, to collect human body or environmental signals
		Test with extra sensor	Use extra sensors, such as an ultrasound probe, to collect human body or environmental signals
In vitro test	Test that requires sample consumption; biological components or organisms are detected from samples, such as blood, sweat, etc.	Tube strip and specimen inspection	Take a specimen of bodily fluid and directly inspect the result using the built-in camera or microscope connected to a smartphone
		Microfluidic testing	Take a specimen of bodily fluid and use microfluidic technique to perform complicated biochemical tests and visualize the result using a smartphone

Table 2.
Categories of smartphone-based test [14].

the in-clinic applications of smartphones involve the diagnostics of specific types of diseases and are supposed to help make clinical decisions [19, 20]. For example, a single-channel electrocardiograph (ECG) can be integrated at the back case of an iPhone and a plug-and-play blood pressure monitor can wirelessly link to a smartphone. Smartphones, equipped with a computer-like platform and various types of sensors, have several properties promoting their uses in in vivo and in vitro test [14]. This confirms that mobile and network technologies are becoming widely accessible even in resource-limited areas lacking adequate healthcare facilities.

1.3 Microfluidic Lab-on-a-Chip technology

The idea of a technology for a device unifying data acquisition and measurement together with sensing and analysis and a response to analysis result was brought into practice for the first time in 1979. By the late 80s and early 90s, Lab-on-a-Chip technology experienced a fast development of total analysis microsystems (uTAS)

[21–24]. These systems were formerly designed for improving chemical separation techniques, particularly capillary electrophoresis, and were later applied in experiments with biological materials [25], DNA and RNA, cells and bacteria, proteins, etc., motivated by the potential market for biomedical research [26]. Microfluidic-based biosensors, primarily dedicated to the detection of biomolecules such as proteins, enzymes, peptides, and DNA, are proposed in the biomedical field as tools to monitor cell behavior on a miniaturized scale, with high sensitivity and resolution and low costs [27]. By detecting cellular analytes, electrical activities, and chemical and physical signals transmitted by the cells, microfluidic-based biosensors provided insights into cellular activities and responses in real time [28]. As a result, microfluidic-based biosensors—also known as Lab-on-a-Chip (LoC) devices—became more and more popular.

LoC devices are promoted for biomedical, biotechnology, chemical, and environmental monitoring applications as a response to the necessity of time effective, low cost, automated laboratory tests by integrating one or more functions in one miniaturized device, such as sample transport, reagent mixing, heating, evaluation, analysis, and synthesis [29–32]. LoC technology integrates microfluidic and electronic components onto the same chip for the development of hybrid devices to reduce laboratory processes in a manner competitive to bench-top instruments [22]. LoC technology emphasizes integration, chip programmability, increased sensitivity, minimal reagent consumption, sterilization, and efficient sample detection and separation. A typical LoC device contains microchannels, which not only allow liquid samples to flow inside the chip, but also integrates measuring, sensing, and actuating components such as microvalves, micromixers, microelectrodes, thermal elements, and optical apparatuses [23]. Microfluidic-based LoC devices have also become very attractive nowadays as they force the development of personalized devices for point-of-care treatments, and enable the fabrication of the next generation of portable and implantable bioelectronic devices [24]. Due to their biosensing capability and embedding concept, the microfluidic-based LoC systems are attractive platforms for developing implantable bioinspired sensors that can be integrated with communication and network technology [33].

2. Methodology: technology identification process

Because international public health security is a relatively new topic of interest and inquiry, one would not expect to find a well-established body of literature surrounding this theme. However, to identify potentially relevant technology solutions for international public health security, I conducted a horizon scan to understand the mHealth-based microfluidic Lab-on-a-Chip technology that could benefit international public health security. In order to identify potential transformative technology, I reviewed non-peer-reviewed gray literature, technology reviews, and peer-reviewed scientific literature for recent development in the LoC technology and fabrication protocols. Searches were conducted through PubMed, Google, Google Scholar, and Web of Science databases.

3. Fabrication protocols and chip materials

There are many fabrication protocols and materials for prototyping LoCs. A design framework can be used with these fabrication materials and methods in recourse-limited settings, discussed in the following section.

3.1 Photolithography

Photolithography is one of the earliest and still one of the most popular methods for fabricating LoCs. The photolithography and etching method for fabricating mask and LoCs relies on the traditional photo developing method. The process involves using negative or positive photoresists. Photoresists are exposed to high intensity UV-wavelengths through masks and spin coated. In photolithography, there are mask and mask-less methods. Mask-less photolithography can be achieved by methods whereby light is spatially modulated and light patterns can be manipulated at every pixel. In photolithography, before etching with chemicals, a UV resist can be used to spin coat chemicals and focused UV light can be beamed onto the photoresist [34].

3.2 Softlithography

In softlithography, the reverse master is designed and fabricated in such a way as to have protruding patterns on its surface. It can be the positive or negative image of a target LoC. Silicon, PMMA, or a chemical-coated PDMS can be made to bear the master image. One of the benefits of softlithography is that it can be used to fabricate LoCs with three-dimensional microfluidics channels and also to form microstructures, including channels, and submacrostructures, including cell-culture chambers [29, 30, 35]. Softlithography technique is convenient, straightforward to apply, accessible to a wide range of users, and low-cost nonphotolithographic-based approach for micro and nanofabrication. Some softlithography techniques are: microcontact printing (μ CP), microtransfer molding (μ TM), replica molding (REM), micromolding in capillaries (MIMIC), and solvent-assisted micromolding (SAMIM). **Table 3** compares the advantages and disadvantages of conventional photolithography and softlithography [29].

3.3 Microembossing

Microembossing, also known as microtransfer molding or hot-embossing, is the process by which the configuration of microfluidic channels is transferred onto

	Photolithography	Softlithography
Definition of patterns	Rigid photomask	Elastomeric stamp or mold
Materials that can be patterned directly	Photoresists	Photoresists
	SAMs on Au and SiO ₂	SAMs on Au, Ag, Cu, GaAs, Al, Pd, and SiO ₂ Precursor polymers Polymer beads Sol-gel materials Conducting polymers Colloidal materials Organic and inorganic salts Biological macromolecules
Surfaces and structures that can be patterned	Planar surface Two-dimensional structures	Both planar and nonplanar Both two-dimensional and three-dimensional structures
Resolution	100 nm	From 30 nm to 1 μ m

Table 3. Comparison between photolithography and softlithography [21–24, 29, 30, 33–35].

the thermoplastic material. The polymer material is pressed with a heated barrel so that the material becomes soft and molted. By applying pressure and heat onto the polymer sheet, the shape is then transferred from metal press to the sheet. To transfer microscale patterns inexpensively, the hot-embossing method can be used. Such a method is affordable, assessable, and available even to resource-constrained laboratories for the production of disposable LoCs [31].

3.4 Injection molding

In injection molding fabrication protocol, the injection of molten thermoplastic involves under high pressure into a heated closed master mold, followed by cooling until the thermoplastic solidifies, and subsequent demolding the replica from the master mold. For industrial scale manufacturing of macroscopic objects in thermoplastics that has been adopted for micromanufacturing, injection molding is a well-established technique [32].

3.5 PDMS Lab-on-a-Chip

PDMS (polydimethylsiloxane) is a straightforward, adaptable, and low-cost polymer that can be used to fabricate LoC by the softlithography. Research laboratories commonly use PDMS for LoC prototyping, which is one of the least resource demanding fabricating methods. PDMS is also broadly utilized on the grounds that it is simple and shabby to create PDMS LoCs [36]. Moreover, LoC made of PDMS takes preferred standpoint of the simple mix of shudder miniaturized scale valves for quick stream switch and penetrability of air for cell-and-tissue-culture-LoCs [37]. Commonly utilized for LoCs prototyping, PDMS demonstrates extreme impediments for modern generation. The properties of PDMS are surprisingly close to that could be obtained from glass and plastic. The cross-linking of many of these polymer chains makes a structure that is flexible and reversibly deformable. **Table 4** summarizes the physical properties of PDMS, and **Table 5** compares polymer and glass as substrate for chemical and biomedical applications [36]. Many of properties demonstrate that the PDMS is very desirable for fabricating microfluidic LoCs.

3.6 Thermoplastic-polymers Lab-on-a-Chip

Irrespective of the opportunity that it is a little bit more uncertain and expensive to actualize than PDMS, thermoplastics are great contender for the manufacture of LoCs. Thermoplastic polymers are generally utilized by specialists to manufacture LoCs. Polymethyl methacrylate (PMMA), given its transparency, can be used as the positive tone photoresist in X-ray lithography and e-beam lithography processes [38]. Cyclic-olefin Copolymer (CoC) polymer is a popular fabrication material for various applications, including lenses and medical devices. CoC can also be used for the 3D printing of microfluidic LoC devices. PolyCarbonate (PC), which is more inert to chemical solvent than PDMS therefore, can be useful for some LoC applications where PDMS are not suitable for the required LoC applications. However, fabricating LoCs using PC requires investment intensive high-pressure embossing micromachining tools. Poly vinyl alcohol (PVA) is used for fabricating sophisticated LoCs with three-dimensional polymer microstructures. PVA can be dissolved in water but not in solvents, so they can be used as sacrificial materials. One more type of polymer not directly used for fabricating LoCs but still useful for biomedical application is Parylene. Parylene allows the transmission of waves in the visible spectrum, and it is not porous and can be coated onto electronics to prevent it from

Property	Characteristic	Consequence
Optical	Transparent UV cut-off = 240 nm	Optical detection from 240 to 1100 nm
Electrical	Insulating Breakdown voltage = 2×10^7 v/m	Allows embedded electrical circuits Electrophoresis possible on contained fluid
Mechanical	Elastomeric Young's modulus typically 750 kPa	Conforms to surfaces Facilitates release from molds
Thermal	Insulator Thermal conductivity 0.2 W/(m K) Thermal expansion coeff. 310 $\mu\text{m}/(\text{m}^\circ\text{C})$ Can withstand 200°C	Does not allow the dissipation of optical absorption heating or electrophoretic resistive heating Can be autoclaved for sterilization
Permeability	Impermeable to liquid water Permeable to gases and nonpolar solvents	Contain aqueous solutions in channels; allow gas transport through material bulk Incompatible with many organic solvent
Reactivity	Inert Oxidized by plasma exposure	Unreactive toward most reagents, including ethanol Surface can be etched Can be modified to be hydrophilic and also reactive toward silanes Can be permanently bonded
Toxicity	Nontoxic	Can be implanted in vivo Supports mammalian cell cultures

Table 4.
Physical properties of PDMS [36].

	Polymers	Glass
Manufacturing costs	Lower costs than glass, especially in mass volume	More expensive to manufacture as fabrication process is more complex
Fabrication complexity	Simple fabrication process	Time-consuming and expensive, and usually wet chemistry is used
Clean room facilities	Cleanroom environment is necessary	Cleanroom facilities are required
Operation temperature	Narrow range due to the low glass transition temperature	Wider range of operation temperature than polymer
Optical properties and fluorescence detection	Higher autofluorescence in the UV end of the spectrum and lower transparency than glass	Superior optical property than glass
Compatibility with organic solvents or strong acids	Generally not compatible with most organic solvents	Excellent resistance to solvents and acids
Permeability to gases	Higher gas permeability relative to glass	Does not meet the gas permeability requirements for some biological applications
Geometrical flexibility	More flexibility for geometrical designs with a wide selection of different cross-sections; high aspect ratio and arbitrary wall angle	Limited to two-dimensional design due to isotropic nature of etching process. Less flexibility in cross-sections than polymer

Table 5.
Comparison between polymer and glass as the substrate of microfluidic LoC systems for biomedical and chemical applications [36].

corroding and avoiding electrical short circuiting [34]. For specific applications, some exploration groups acquired great outcomes with thermoplastic-polymers LoCs, and since it is feasible to integrate microelectrodes into these polymers, thermoplastic polymers are having evident opportunity for the industrial development of some LoCs [39].

3.7 Silicon and glass Lab-on-a-Chip

The earliest LoCs were fabricated in silicon, and it appears like a significant characteristic decision since smaller scale innovations depend on the micromachining of silicon [35]. These days' scientists do not frequently utilize silicon for LoC, for the most part since silicon is costly, not optically nontransparent, and requires a spotless room. Moreover, the electrical conductivity of silicon makes it difficult to use for LoC operations. Still, silicon is relevant choice for the industrialization of some LoC applications. Analogous to silicon, glass is also the earliest fabrication material for LoCs. Glass is a hard material to fabricate chip but a useful material due to its inertness and transmutability of wavelengths in UV, IR, and visible regions [40]. However, fabricating LoCs in glass requires hazardous chemicals and lengthy time intervals, expensive facilities. From an exploration perspective, the creation of glass LoCs requires clean rooms and specialists with solid information of microfabrication techniques.

4. Advantages of microfluidic Lab-on-a-Chip technology

Globally, every country confronts parallel challenges in keeping its inhabitants healthy and preventing the cross-border spread of infectious diseases. Biomedical engineers, synthetic chemists, and biologists along with public health professionals are evaluating the potentiality of microfluidic LoC technology in the context of international public health security. In recent years, certain applications have emerged, from the detection of infectious diseases to diagnostics for international public health [41]. Several on-chip clinical assessments have also appeared include cell analysis, cytometry, blood analysis, nucleic acids amplification, genetic mapping, enzymatic assays, peptide analysis, protein separation, toxicity analysis, and bioassays [42]. In the area of drug research, the LoC devices have gradually become significant with the prominence on cell targeting, clinical trials, drug synthesis, pharmaceutical formulations, and product management process [43]. The LoC devices are found promising in the analysis of drugs and determination of optimal dosages. This is especially useful for testing the synergistic effect of combined drugs [44]. In recent past, microfluidic LoCs presented an exclusive prospect to replicate natural veins for testing nanoparticles as drug carriers for targeting cells or, moreover, presented opportunities for investigate in vitro metabolism of biological cultures [45].

Compactness, portability, modularity, embedded computing, automated sample handling, low electronic noise, limited power consumption, and straightforward integration of various components are some notable technical advantages of LoC devices [46]. Furthermore, LoC devices are capable of supporting a wide range of processes such as sampling, routing, transport, dispensing, and mixing, mostly with reduced moving or spinning mechanisms [47]. Due to their small size, the LoC devices offer precise fluidic transportation via the use of electrokinetics or micro-pumping, efficient separation of the liquid samples, and precision in the measurement of samples [48]. Likewise, the LoC devices can reduce the time of synthesis of a product and the time of analysis of a sample because of the small fluidic volumes

that they handle. LoC devices can also measure samples with greater precision, with their capability of controlling the chemical reactions through efficient control of the reactants concentration [49].

In the same way, the field of clinical medicine deeply benefited from microfluidic LoC technology as it suites for disease modeling and drug screening [50], tests for observing pandemics [51], glucose monitoring, diabetic control, diagnosis of diseases, and numerous other tests [22, 52]. LoC devices enhance numerous biomedical tests that entail mixing, analysis, and separation of samples, which usually consist of cell suspensions, nucleic acids, and proteins; analytical, electrical, or optical detection methods are also possible [53]. Key manufacturing advantages that make microfluidic LoC technology reasonable are: achievable mass production, affordable replacement cost, short time manufacture, simple quality tests, and broad range of supporting computer-aided design and simulation software tools [54]. However, the technical limitations such as size reduction, sample input rates, power consumption, chip reliability, and biocompatibility all still require further investigations in the design of microfluidic LoC technology [55].

5. Research potential of mHealth-based microfluidic Lab-on-a-Chip technology for international public health security

In era of international public health catastrophe, academia, industry, the R&D community, and governments must be stimulated as an interconnected group to promptly determine the obligatory biomedical engineering and international public health interventions. Achieving significant acceleration in R&D related to international public health security requires significant amount of new directions because it is critical to use the best technology, investigation, and development to strengthen international public health defense. However, the simplicity and system integration provided by microfluidic LoC technology for the implementation of multiple tasks, such as sample preparation, separation, amplification, and detection, have largely extended their use in biomedical and international public health applications [56, 57]. Examples of their uses are immunoassays with plasma generation for electrochemical detection, infectious disease diagnostics based on platforms that integrate sample preparation, PCR, integrated valves for DNA-based diagnosis, quantification, and biochemical analysis for the evaluation and quality control of DNA, RNA, proteins, and cells together with fluorescence or similar visualization methods [58, 59].

Microfluidic LoC technology is an excellent choice for integrating mHealth-based point-of-care devices in resource-limited settings, offering portable medical analysis without the need of costly and sophisticated equipment, and the fast obtention of results without involving an extensive knowledge of the diagnosis principle involved [60–64]. Several studies have proven the effectiveness of LoC devices as portable point-of-care diagnosis tools in the detection of infected microorganisms, biological analytes, and blood analysis [61, 62]. Microfluidic LoC systems can also be used for controlled, personalized drug delivery according to patient's response, extent of disease, and current conditions [63]. Besides, key advantages that mHealth-based microfluidic LoCs can offer for international public health are facilitating early-stage accurate diagnosis, maintaining better communication and monitoring of patients, enabling better tracking of disease outbreaks, and improving the epidemiological surveillance of diseases, which are predominantly challenging problems for international public health security.

6. Conclusion

It is widely discussed that microfluidic LoC technology has great potential to revolutionize the international public health field and possess the capability to give a boost to international public health security. There is a pressing need for new health technologies for diagnosing and treating avoidable international public health problems. mHealth-based microfluidic LoC technology still seem to be a dream especially in resource-limited settings. One of the biggest challenges in the field of mHealth-based microfluidic LoC is the translation from academic research to end-user products. While the field of microfluidic LoC technology has seen an exponential development in recent past, the launch of a commercialized platform that would revolutionize the concept of mHealth-based microfluidic LoC technology is still lacking. A bottleneck that hinders the adoption of microfluidic LoCs in international public health and mHealth applications remains due to the facility and skill requirement and knowledge gap. Despite barriers and challenging issues, many great opportunities are still waiting ahead. There are no “one size fits all” solutions for modeling complex international public health security problems “on a chip.” Tackling the international public health security challenges in a way that yields meaningful advances will therefore require bringing together groups with diverse expertise in biomedical engineering, synthetic biologist and chemist, microfluidic LoC technology professionals, international public health, and health security experts.

Conflict of interest


The author declares that there is neither conflict nor financial interest. No writing assistance was utilized in the production of this manuscript.

Author details

Mirza Abdul Aleem Baig
Center for Biomedical Engineering, University of Science and Technology of China,
Hefei, Anhui, China

*Address all correspondence to: baig@mail.ustc.edu.cn

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] World Health Organization. The world health report 2007: A safer future: global public health security in the 21st century; 2007
- [2] Christian KA, Iuliano AD, Uyeki TM, Mintz ED, Nichol ST, Rollin P, et al. What we are watching—Top global infectious disease threats, 2013-2016: An Update from CDC's global disease detection operations center. *Health Security*. 2017;**15**(5):453-462
- [3] Threats I, Knobler S, Mack A, Mahmoud A, Lemon S. The Story of Influenza [Online] Ncbi.nlm.nih.gov. 2005. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK22148/> [Accessed: 09 October 2019]
- [4] New England Journal of Medicine. After Ebola in West Africa — Unpredictable Risks, Preventable Epidemics[NEJM] [Online]. 2016. Available from: <https://www.nejm.org/doi/full/10.1056/NEJMSr1513109> [Accessed: 09 October 2019]
- [5] Guo C, Zhou Z, Wen Z, Liu Y, Zeng C, Xiao D, et al. Global epidemiology of dengue outbreaks in 1990-2015: A systematic review and meta-analysis. *Frontiers in Cellular and Infection Microbiology*. 2017;**7**:317
- [6] World Health Organization. Global Strategy for Dengue Prevention and Control. Avenue Appia, Geneva, Switzerland: WHO Press; 2012-2020; 2012. ISBN: 978 92 4 150403 4
- [7] Baig M. Infectious Diseases and National Security: Who will frame National Health Security Policy of Pakistan? [Online] *Modern Diplomacy*. 2019. Available from: [https://modern diplomacy.eu/2019/09/16/infectious-diseases-and-national-health-security-policy-of-pakistan/](https://modern diplomacy.eu/2019/09/16/infectious-diseases-and-national-security-who-will-frame-national-health-security-policy-of-pakistan/) [Accessed: 10 October 2019]
- [8] Boyd AT, Cookson ST, Anderson M, Bilukha OO, Brennan M, Handzel T, et al. Centers for disease control and prevention public health response to humanitarian emergencies. *Emerging infectious diseases*. 2007-2016. 2017;**23**(1 Suppl):S196
- [9] Who.int. (2019). WHO | Disease outbreaks. [Online] Available at: https://www.who.int/environmental_health_emergencies/disease_outbreaks/en/ [Accessed 10 Oct. 2019].
- [10] Walsh B. U.S. [Online] *TIME.com*. 2017. Available from: <https://time.com/magazine/us/4766607/may-15th-2017-vol-189-no-18-u-s/> [Accessed October 10, 2019]
- [11] McCracken K, Phillips DR. *Global Health: An Introduction to Current and Future Trends*. London: Routledge; 2017. Available from: <http://doi.org/10.4324/9781315691800>
- [12] World Health Organization. *World Health Statistics 2016: Monitoring Health for the SDGs, Sustainable Development Goals*; World Health Organization, WHO Press; 2016. ISBN: 978 92 4 1556526 4
- [13] Fortuin J, Salie F, Abdullahi LH, Douglas TS. The impact of mHealth interventions on health systems: A systematic review protocol. 2016;**5**(1): 200
- [14] Xu X, Akay A, Wei H, Wang S, Pingguan-Murphy B, Erlandsson BE, et al. Advances in smartphone-based point-of-care diagnostics. *Proceedings of the IEEE*. 2015;**103**(2):236-247
- [15] Davis TL, DiClemente R, Prietula M. Taking mHealth forward:

Examining the core characteristics.
JMIR mHealth and uHealth. 2016;4(3):
e97

[16] Itu.int. World Telecommunication/
ICT Indicators database [Online]. 2018.
Available from: <https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx>

[17] Statista. Number of mobile phone
users worldwide 2015-2020 [Online].
2018. Available from: <https://www.statista.com/statistics/274774/forecast-of-mobile-phone-users-worldwide/>

[18] Jusoh S. A survey on trend,
opportunities and challenges of
mHealth apps. International Journal of
Interactive Mobile Technologies (ijIM).
2017;11(6):73-85

[19] Majumder S, Mondal T, Deen MJ.
Wearable sensors for remote health
monitoring. Sensors. 2017;17(1):130

[20] Munos B, Baker PC, Bot BM,
Crouthamel M, Vries G, Ferguson I,
et al. Mobile health: The power of
wearables, sensors, and apps to
transform clinical trials. Annals of
the New York Academy of Sciences.
2016;1375(1):3-18

[21] Dixit CK, Kaushik AK, Kaushik A.
Microfluidics for Biologists. Weinheim,
Germany: Springer, Wiley-VCH
Verleag GmbH & Co. KGaA, Boschstr;
2016;12:69469

[22] Lafleur JP, Jönsson A, Senkbeil S,
Kutter JP. Recent advances in lab-on-
a-chip for biosensing applications.
Biosensors and Bioelectronics.
2016;76:213-233

[23] Aeinehvand MM, Ibrahim F,
Al-Faqheri W, Joseph K, Madou MJ.
Recent advances in the development
of micropumps, microvalves and
micromixers and the integration
of carbon electrodes on centrifugal

microfluidic platforms. International
Journal of Nanotechnology.
2018;15(1-3):53-68

[24] Miled A, Greener J. Recent
Advancements Towards Full-System
Microfluidics. Sensors. 2017;17(8):1707.
Available from: <https://doi.org/10.3390/s17081707>

[25] Novo P, Jender M, Dell'Aica M,
Zahedi RP, Janasek D. Free flow
electrophoresis separation of proteins
and DNA using microfluidics and
Polycarbonate membranes. Procedia
Engineering. 2016;168:1382-1385

[26] Zhang L, Wan S, Jiang Y, Wang Y,
Fu T, Liu Q, et al. Molecular elucidation
of disease biomarkers at the interface of
chemistry and biology. Journal of
the American Chemical Society.
2017;139(7):2532-2540

[27] Klipp E, Liebermeister W,
Wierling C, Kowald A,
Herwig R. Systems Biology: A Textbook.
Weinheim, Germany: John Wiley &
Sons, Wiley-VCH Verlag GmbH & Co.
KgaA, Boschstr; 2016;12:69469

[28] Mehrotra P. Biosensors and their
applications—A review. Journal of Oral
Biology and Craniofacial Research.
2016;6(2):153-159

[29] Liu X. An Intermediate-Layer
Lithography Method for Producing
Metal Micron/Nano Patterns
and Conducting Polymer-Based
Microdevices. United States: Louisiana
Tech University, ProQuest Information
and Learning Company; 2007

[30] Xia Y, Whitesides GM. Soft
lithography. Angewandte Chemie
International Edition. 1998;37(5):550-
575

[31] Cordero JLG. Development of
Innovative Microfluidic Polymeric
Technologies for Point-of-care and

- Integrated Diagnostic Devices [Doctoral dissertation]. Dublin City University. School of Physical Sciences
- [32] Tom AM. An Investigation of Micro-Scale Fabrication Using the Injection Molding Process. Pennsylvania, United States: Lehigh University; 2007:3285741
- [33] Zarei M. Portable biosensing devices for point-of-care diagnostics: Recent developments and applications. *TrAC Trends in Analytical Chemistry*. 2017;**91**:26-41
- [34] Menon R, Patel A, Gil D, Smith HI. Maskless lithography. *Materials Today*. 2005;**8**(2):26-33
- [35] Ren K, Zhou J, Wu H. Materials for microfluidic chip fabrication. *Accounts of Chemical Research*. 2013;**46**(11):2396-2406
- [36] McDonald JC, Whitesides GM. Poly (dimethylsiloxane) as a material for fabricating microfluidic devices. *Accounts of Chemical Research*. 2002;**35**(7):491-499
- [37] Oncescu V, Mancuso M, Erickson D. Cholesterol testing on a smartphone. *Lab on a Chip*. 2014;**14**(4):759-763
- [38] Tseng AA, Chen K, Chen CD, Ma KJ. Electron beam lithography in nanoscale fabrication: Recent development. *IEEE Transactions on Electronics Packaging Manufacturing*. 2003;**26**(2):141-149
- [39] Alrifaiy A, Lindahl OA, Ramser K. Polymer-based microfluidic devices for pharmacy, biology and tissue engineering. *Polymers*. 2012;**4**(3):1349-1398
- [40] Licari JJ. Coating Materials for Electronic Applications: Polymers, Processing, Reliability, Testing. Noyes Publications William Andrew Inc.; 2003. ISBN: 0-8155-1492-1
- [41] Fu E, Yager P, Floriano PN, Christodoulides N, McDevitt JT. Perspective on diagnostics for global health. *IEEE Pulse*. 2011;**2**(6):40-50
- [42] Alam MK, Koomson E, Zou H, Yi C, Li CW, Xu T, et al. Recent advances in microfluidic technology for manipulation and analysis of biological cells (2007-2017). *Analytica Chimica Acta*. 2018;**1044**:29-65
- [43] Mancera-Andrade EI, Parsaeimehr A, Arevalo-Gallegos A, Ascencio-Favela G, Parra RS. Microfluidics technology for drug delivery: A review. *Frontiers in Bioscience (Elite Edition)*. 2018;**10**:74-91
- [44] Khalid N, Kobayashi I, Nakajima M. Recent lab-on-chip developments for novel drug discovery. *Wiley Interdisciplinary Reviews: Systems Biology and Medicine*. 2017;**9**(4):e1381
- [45] Ahn J, Ko J, Lee S, Yu J, Kim Y, Jeon NL. Microfluidics in nanoparticle drug delivery; From synthesis to pre-clinical screening. *Advanced Drug Delivery Reviews*. 2018;**128**:29-35
- [46] Raj SV, Stanley J, Satheesh Babu TG. Fabrication of a configurable multi-potentiostat for LOC applications. *Materials Today: Proceedings*. 2018;**5**(8):16732-16739
- [47] Fobel R. Development of an automated and scalable lab-on-a-chip platform with on-chip characterization [Doctoral dissertation]; 2016
- [48] Samiei E, Tabrizian M, Hoorfar M. A review of digital microfluidics as portable platforms for lab-on a-chip applications. *Lab on a Chip*. 2016;**16**(13):2376-2396
- [49] Mashaghi S, Abbaspourrad A, Weitz DA, van Oijen AM. Droplet microfluidics: A tool for biology, chemistry and nanotechnology. *TrAC Trends in Analytical Chemistry*. 2016;**82**:118-125

- [50] Skardal A, Shupe T, Atala A. Organoid-on-a-chip and body-on-a-chip systems for drug screening and disease modeling. *Drug Discovery Today*. 2016;**21**(9):1399-1411
- [51] Adekanmbi EO, Srivastava SK. Dielectrophoretic applications for disease diagnostics using lab-on-a-chip platforms. *Lab on a Chip*. 2016;**16**(12):2148-2167
- [52] Syedmoradi L, Daneshpour M, Alvandipour M, Gomez FA, Hajghassem H, Omidfar K. Point of care testing: The impact of nanotechnology. *Biosensors and Bioelectronics*. 2017;**87**:373-387
- [53] Wu J, Lin JM. Biochemical analysis techniques integrated on microfluidic chips and their applications. In: *Cell Analysis on Microfluidics*. Singapore: Springer; 2018. pp. 313-338
- [54] Tsao CW. Polymer microfluidics: Simple, low-cost fabrication process bridging academic lab research to commercialized production. *Micromachines*. 2016;**7**(12):225
- [55] Folch A. Introduction to bioMEMS. Taylor & Francis Group, LLC, CRC Press; 2016. ISBN: 13: 978-1-4665-0938-2
- [56] Vilela D, Romeo A, Sánchez S. Flexible sensors for biomedical technology. *Lab on a Chip*. 2016;**16**(3):402-408
- [57] Yeo JC, Lim CT. Emerging flexible and wearable physical sensing platforms for healthcare and biomedical applications. *Microsystems & Nanoengineering*. 2016;**2**:16043
- [58] Giri B, Pandey B, Neupane B, Ligler FS. Signal amplification strategies for microfluidic immunoassays. *TrAC Trends in Analytical Chemistry*. 2016;**79**:326-334
- [59] Duffy DC, Song L, Shan D, Zhao M. Quanterix Corp, 2018. Detection of DNA or RNA using single molecule arrays and other techniques. U.S. Patent 9,932,626
- [60] Choi S. Powering point-of-care diagnostic devices. *Biotechnology Advances*. 2016;**34**(3):321-330
- [61] Contreras-Naranjo JC, Wei Q, Ozcan A. Mobile phone-based microscopy, sensing, and diagnostics. *IEEE Journal of Selected Topics in Quantum Electronics*. 2016;**22**(3):1-14
- [62] Romeo A, Leung TS, Sanchez S. Smart biosensors for multiplexed and fully integrated point-of-care diagnostics. *Lab on a Chip*. 2016;**16**(11):1957-1961
- [63] Astolfi M, Péant B, Lateef MA, Rousset N, Kendall-Dupont J, Carmona E, et al. Micro-dissected tumor tissues on chip: An ex vivo method for drug testing and personalized therapy. *Lab on a Chip*. 2016;**16**(2):312-325
- [64] Nayak S, Blumenfeld NR, Laksanasopin T, Sia SK. Point-of-care diagnostics: Recent developments in a connected age. *Analytical Chemistry*. 2016;**89**(1):102-123

Beyond Health and Safety at Work: Reflections on Biopolitics in Occupational Health as an Important Component of International Health Security

Mendes Luciano

Abstract

The general objective in this chapter is to reflect on health and safety at work based on biopolitics and biopower. The intention will be to clarify unequal processes in health and safety at work. In addition to occupational health, occupational health and safety actions aim to increase control over workers' bodies, as well as reduce costs in the work process. The intention is still to establish a dialogue with the French philosopher Michel Foucault and with the Italian philosopher Giorgio Agamben, both discussing the consequences of biopolitics and biopower in industrial society modern. The proposed reflections go beyond the benefits of occupational health and safety at work, as they aim to understand the centrality of life in industrial organizations. It is important and necessary to minimize the negative effects of inequality in health and safety at work. Only then will there be a reduction or elimination of health and safety risks at work.

Keywords: occupational health, safety at work, biopolitics, biopower

1. Introduction

Occupational medicine emerged in England in the first half of the nineteenth century during the Industrial Revolution. With the frequent number of illnesses and deaths in the workplace, occupational medicine emerges as a form of intervention and minimizing the damage caused by occupational diseases. A classic case is that of Robert Dernham, owner of a textile industry, who sought out Doctor Robert Baker to find out how he could minimize cases of illness and death in the workplace. Baker told Dernham to invite a doctor to periodically visit the workplace to find out what could be done preventively to reduce cases of illness and death [1].

It did not take long for occupational medical services to emerge in various industries. The expansion of medical services in industrial rather than solve or minimize the problems of disease and death in the workplace, enabled a level of dependency of workers and their families of medical services. With the inefficiency of public health services, especially in peripheral countries, medical services in

industrial companies have become an important factor for the dependence of the worker in relation to the industry [2].

The concern to provide medical services to workers also becomes a concern of the International Labor Organization (ILO). In 1953, the ILO creates a document that generates guidelines on the “protection of workers’ health.” In 1954, the ILO convened a group of experts to create general guidelines on “Occupational Medical Services,” which in 1958 was replaced by “Occupational Health Services”. In the ILO document, the Occupational Health Services must: (a) ensure the protection of workers against all risks that harm their health and that may result from their work and the conditions in which it is carried out; (b) to contribute to the physical and mental adaptation of the worker, in particular by the suitability of the work and its placement in workplaces corresponding to their skills; and (c) contribute to the establishment and maintenance of the highest possible level of physical and mental well-being of workers [3].

During and after the Second World War, many industries suffered from cases of illness, but mainly from deaths in the workplace. The tension produced by the war significantly increased the number of deaths in industries, where the actions of doctors alone limited the containment of deaths and illnesses. It is in this context that occupational health appears, mainly in large industries, through a multidisciplinary team that comprised doctors, nurses, psychologists, sociologists, engineers and nutritionists. With this, the emphasis on occupational health becomes hygiene and the work environment [4].

It did not take long for the occupational health movement to undergo a series of changes and influences. Despite the multidisciplinary perspective, the participation of workers in the occupational health movement was still peripheral. As a result, in the 1960s, a series of demonstrations took place, mainly in developed countries, for greater participation by workers in actions on health and safety at work [5]. From that time on, legislation on health and safety at work began to emerge, as occurred with Italy in 1970 with the enactment of the Law known as the “Workers’ Statute.” This law required, among many other actions, the participation of workers in the surveillance of health and safety at work actions and also the independent inspection actions of the industry [6]. Many developed countries, such as England, Sweden, France and Norway, for example, had their Labor Laws enacted and in all of them there were rights and guarantees of health and safety at work.

Occupational health and safety appear as elements not only of occupational health, but as effective actions to control and maintain work processes. In addition to the legal aspects, health and safety at work become normative. Prescriptive work becomes central to industries, as they aim to reduce the indicators of accidents and diseases in the workplace. Prescriptive work integrates two fundamental components: working conditions (physical environment and socioeconomic conditions) and prescriptions (norms, procedures and rules). But prescriptive work is far from real work. What is prescribed is not what actually happens. For this reason, even with the spread of health and safety standards at work, accidents, illnesses and deaths caused by work are still occurring and increasing in recent years [7].

According to data from the International Labor Organization (ILO) more than 2.7 million people die from occupational accidents. There are over 370 million people who suffer non-fatal accidents and are on leave for 4 days or more from work. Accidents at work generate an economic cost of about 4% of the Global Gross Domestic Product per year. These data show that advances in health and safety at work policies and actions have not had a positive impact on the work environment [8]. At this point, it is necessary to discuss the political dimension of this process and make evident the inequalities in relation to health and safety at work. As the ILO report itself shows, the countries that suffer most from deaths, accidents

and illnesses at work are the poor countries. And it is not only due to an unfavorable economic condition, as many of these countries have rapidly industrialized, receiving many international industries, which seek low social and environmental regulations [9]. But it is the question of the value of human life [10].

Who deserves to live and who can die. Where regulations must be met and where those regulations must not be met. In view of these inequalities in relation to actions on health and safety at work, subsequent theoretical discussions take place. And an important aspect in this path will be the discussions about biopolitics and biopower carried out by Michel Foucault and Giorgio Agamben, which show this political process and power over life, generating different values about human lives. Thus, the general objective of this chapter is to reflect on health and safety at work from biopolitics and biopower, showing that there is an evident contribution to the discussions on International Health Security. Therefore, initially it will be important to present some methodological explanations. Then, the theoretical discussions on health and safety at work. Soon after, to present the ideas of biopolitics and biopower in Michel Foucault and Giorgio Agamben, highlighting the central aspects of health and safety at work practices. Finally, some final considerations.

2. Research methods

This text is characterized by a bibliographic essay [11], written from a bibliographic survey on the topic of Health and Safety at Work. The focus of this text was to understand Health and Safety at Work as an important perspective for International Health Security. As a result, papers were selected that discussed, at the international level, health and safety at work, bringing a history of the development of health and safety within organizations. In this history, actions in health and safety at work were taken into account since the emergence of the industrial system, as well as the nomenclatures on health and safety at work and the linear periods of time in which actions were developed. Although only one paper was cited in each period, the bibliographic survey made it possible to validate the information among the papers cited in the text.

Subsequent to this linear path on the evolution of health and safety practices at work in organizations, the second part was developed through a reading of health and safety at work based on the concepts of biopolitics and biopower by Michel Foucault and Giorgio Agamben. In this part, a survey was made on the texts of Foucault and Agamben that deal with the concepts of biopolitics and biopower, relating them to the discussions on Health and Safety at Work. The intention was to show that the rapid development of Health and Safety at Work and that it made an important contribution to International Health Security were linked to changes in the policy of capitalist countries. Biopolitics and biopower are the basis of International Health Security and are reflected in actions on Health and Safety at Work.

3. Health and safety at work

In this part, the various actions on health and safety at work, nor the various safety and ergonomic standards created for the work environment will not be explored. The intention will be to conduct a comprehensive discussion on the topic with a view to understanding the intricacies of health and safety at work actions. Thus, some actions on health and safety at work will be presented but with the intention only of understanding its intricacies. The focus will be the description and not the prescription that is established in health and safety at work.

Occupational health and safety are terms linked to occupational health and have expanded the way illnesses and accidents are understood in the work environment [12]. Work-related risks are no longer seen only from a physical and chemical perspective and have included biological, ergonomic and psychosocial perspectives [13]. In addition, illnesses are no longer seen only as occupational illnesses that were generated by the work environment and started to include work-related disease and illnesses aggravated by work [14]. These expansions in the way of understanding diseases and accidents accompanied changes in the forms of production and management of industries and organizations [15]. From the industry managed in the Taylorism-Fordist model to flexible production (Toyotas' model), the risks related to work have changed [16].

It was for this reason that the risks of accidents, deaths and illnesses in the work environment started to be quantified and qualified based on technical and management attributes. The strategies to contain risks involved diagnoses of work and organizational environments (risk assessment) that generated strategies to mitigate and contain these risks [17]. Quantitative methods are used, to a large extent, for hygiene actions at work. And qualitative methods for actions in safety at work. Despite the human benefits existing in the various actions in health and safety at work, the focus is still on technical attributes and not human attributes. This focus generates a gap between prescribed work and real work, precisely because human beings tend to adapt work to their conditions of execution [18].

This gap between prescribed work and real work is also reflected in the technical attributes related to the management of health and safety at work. The containment of a risk can generate new risks, as there is a complexity in the working conditions and in the activities developed. For example, the use of personal protective equipment may generate some type of allergy in the worker, precisely because the technical attribute of mitigating a specific risk was thought of, but not in adapting the material to the human organism. In addition, what could be called the minimum acceptable level of risk at work may not trigger a problem in the short term, but be responsible for illnesses, accidents or deaths in the long term. For example, exposure to a certain chemical element may not be harmful in sporadic exposures, but it is a dangerous element precisely because it is accumulated in the human organism. Actions in health and safety at work invalidate the individual aspects of workers, always taking into account aspects related to the majority. The human being continues to be adapted to the work environment and not the other way around. For this reason, health and safety at work actions tend to focus on physical, chemical, biological and ergonomic risks and very little on psychosocial risks. This is because these psychosocial risks are linked to individual attributes, which do not concentrate most cases [19].

With this, it is not only the gap between prescribed work and real work that highlights the problems generated in health and safety at work, but also the problems of unequal treatment of these actions. This does not minimize the importance and existence of actions in health and safety at work but leads to some reflections that are equally important. If accidents, deaths and work-related illnesses continue to happen, then there is something unsaid about the rules and practices aimed at health and safety at work. There is a level of non-compliance with these prescribed actions, which escapes reflections on the number of accidents, deaths and illnesses in the workplace. These inequalities and this level of non-compliance are linked to a broader factor, which is the life of individuals. One might think that the central concern is with life, but there are other factors linked to work in industries and organizations that better explain investments in health and safety at work, as well as inequalities in the actions carried out [20].

Investments in health and safety at work aim to reduce or minimize the costs of accidents, deaths and illnesses generated in the work environment. For this reason, the focus has always been on those risks generated in the work environment, marginalizing work-related disease and illnesses aggravated by work. Like many actions in health and safety at work, they show a minimum level of tolerance to physical, chemical, biological, ergonomic and psychosocial risks, since the total elimination of risk is somewhat illusory [21]. But what is central to this discussion is the value on the lives of these individuals. What hierarchical level are they in the industry or organization, what kind of risks are they exposed to, whether the role in the industry or organization is essential or not, whether the costs generated by accidents, illnesses and deaths are high or not and if following the rules is more advantageous or if working illegally is more favorable (not for the individual but for the industry or organization) [22]. It is this analysis related to inequality in actions on health and safety at work that the next part of this chapter will address. Both Foucault and Agamben reflect on the political level of life, which is a central element in health and safety at work.

4. Biopolitics and biopower in Foucault and Agamben: reflections about the health and safety at work

The political conception of life is not something that arises in today's society. At the time of the Principalities, this political conception of life was constituted from death. The sovereign had the right to dispose of the life of his subjects. Of course, it was not an unlimited right, since this right was constituted from the actions of subjects who transgressed the rules or generated dishonor to kings or princes [23]. In these circumstances, the sovereign's right was to make people die and let them live. This right was derived from the ancient "*patria potesta*," where the Roman father of the family had the right to dispose of the lives of his wife, children and slaves, since he had given them. Despite the strength that the sovereign's right had in relation to his subjects, the Reigns and Principalities were disappearing during the history of civilizations. This allowed for the emergence of another form of policy on life, much more linked to the promotion and care of life than to its finitude and ability to make people die [24].

In the mid-seventeenth century, wide-ranging discussions on the role of the modern state began to emerge. The focus becomes the various investments that could be made to attract and retain individuals in their territories. The actions at the State level were to promote life, through extensive investments in public health, in improving the quality of life and in improving the economic and social condition. Concerns within the states were focused on basic sanitation, urban cleaning, urban infrastructure and health care. In the midst of the emergence of public health, the use of statistics was of central importance [25].

It was possible to assess, based on statistical data, for example, the number of births, the number of deaths, the most common diseases and the migration of people in regions or states. Statistics were so important that even today they are used to generate a level of normalization on diseases, accidents and deaths, not only in society as a whole, but also in industries and organizations. Statistics made it possible to create strategies and actions to contain problems related to the health and safety of the population. The central role of the modern state will be to make people live and let them die, which is the reverse of the sovereign's power [26].

Political actions on the life of the population can demonstrate a level of humanity and care toward individuals. But the exact opposite is starting to happen. Actions

at the State level move quickly away from normalization processes on health conditions, birth and mortality rates, infection and contamination flows for body discipline. This discipline of the glass was important to generate the strength of the industrial system, since the entire production system depended on the labor of the workers [27]. The transformation of docile and useful bodies also involved caring for life. In its eagerness to care for, protect and manage the population's living conditions, the State ends up intensifying the processes of violence. This is because the recognition of what could be called the good life is directly linked to the bad life. It is this inequality that projects the existence of the best living conditions, as the worst living conditions must also be recognized [28].

It is this inequality, this social hierarchy, that will function in government over life. The basis for this inequality will be established, during the nineteenth century, on the theory of biology, particularly on Darwinism. It is from the hierarchy of species, from the struggle for life between species, from the selection that eliminates the least able that a hierarchy over the population is also constituted. That same base that, within the State, was able to institute racism and war [29].

Hierarchical relations within the population and the justifications for genocide in war are at the basis of social Darwinism. It is this inequality that will produce the "making a living," the one considered most apt and who are at the top of the social hierarchy, and the "letting die" for the least able and who are at the bottom of the social hierarchy [30]. The concern with those at the bottom of the social hierarchy occurs only when the costs of "letting it die" are higher and have a direct impact on the industrial system [31]. When the profit is diminished by accidents, deaths and illnesses generated in the work environment, then the actions of "letting live" and not "making it live" are exercised.

That is why the normalization process is important in health and safety at work, because despite generating docile bodies and adapted to the production system, they still generate a way of "letting live." For this reason, too, the prescribed work is distant from real work, as the central concern is not to "make life" for those at the bottom of the social hierarchy, but to establish guidelines that minimize the negative impacts on the industrial system. Accidents, deaths and diseases generate costs for the industrial system and also for the State [32]. Production interruptions, the departure of specialized individuals, sick leave and the hiring of other workers generate large expenses for the industrial system. As well as generating expenses for the State with public health, with disability pensions and with the expansion of hospital systems. All these expenses and costs that burden the capitalist system induce the condition of the prescribed work, in an attempt to establish the discipline of the body, but it remains averse to the human condition [31].

In the midst of this discussion there are differences in life. The Greek term for life as a "naked life" is *Zoé*, which expresses the condition of being alive. The Greek term for "qualified life" is *Bíos*, which expresses the political condition of life. Modernity is based on "*Zoé*" life. It is this politically conceived life that populations are limited [33]. It is on this political conception that it is allowed to kill, maim and fall ill without being guilty of murder, crime or torture. It is this biopolitics that allows us to look at the number of accidents, mutilations or illnesses in the world without blaming the capitalist system or entrepreneurs for this daily genocide. The normalization and standardization processes except the responsibilities for those events considered to be exceptional or pathological [10]. The prescribed work generates a level of non-responsibility and an attempt to adapt human beings to work processes and not the other way around. In other words, work processes and work organization are not altered to better adapt to human factors [34].

The intensification of the processes of biopolitics and biopower, which are exercised over the population, made *Zoé* and *Bíos* take a different form from that

constituted by the Greeks. Biopolitics appropriated Zoé and introduced it to the political condition. This naked and vital life was consumed by political bodies, which started to manage, organize and normalize it. Modernly, Bíos was marginalized, preventing individuals from having dominion over their own living conditions. As a result, the derivations of Bíos were marginalized in today's society: bíos theórétikos (contemplative life), bíos apolaustikós (life of pleasure) and bíos politikos (political life) [35].

Zoé was just a manifestation of the lives of individuals and never entered the political realm. The Greeks had the ability to separate oikos (domestic sphere) and polis (political sphere). Zoé belonged to the domestic sphere and was never within the political condition. Bíos, on the other hand, belonged to the political sphere and led the Greek subject to an active life. Bíos allowed the Greek subject to participate in the actions and decisions of the polis. It made the Greek subject capable of political struggles, the pursuit of pleasures and the choice of a contemplative life. When modernity is understood, it is exactly that active life that has been lost [36].

The modern subject has long lost the ability to control his life (Zoé). Now it is the capitalist system, norms of health and safety at work and management in organizations that determine how it should live and act, how it should be and how it must comply. It is this process of mortification of the human being that has been instituted in modern society [37].

But the question that remains is: would an adaptation of work processes to human conditions not have a positive impact on the capitalist system, generating greater profits and lower social costs? Maybe the answer would be “yes,” but as the good living condition is only verified on the bad living condition, then the best strategy is to maintain this inequality, no longer as a “make you die” condition, as it generates costs to the system, but with conditions to “let live.”

5. Conclusions: reflections on occupational health

It is visible that the discussions on occupational health and also on health and safety at work have advanced a lot in recent years. Everything that has been done to minimize the negative impacts of the industrial system on society is commendable. Much remains to be done, as the rates of accidents, deaths and illnesses related to work remain high. Here, the contradiction between investments in occupational health and the number of accidents, deaths and illnesses at work is already evident, which makes it evident that something is not correct.

Again, it is necessary to repeat that this chapter is not against actions of health and safety at work, but the reflections instituted here aim to shed light on the problem, with the hope that all human life is treated as Bíos (qualified life) and as Zoé (naked life), so that you have respect and responsibility for all lives. The reflections developed here aim to make it clear that in addition to being naked, it is hierarchical and generates uneven living conditions. Only by shedding light on these findings can we fight the processes that maintain these conditions of hierarchy and inequality.

Life starts to be managed, controlled, and normalized, but not for the sole and exclusive good of the subject, but for the good of the capitalist system. Perhaps if accidents, deaths, and illnesses at work did not generate costs for the capitalist system, the right to health and safety at work would follow social inequalities. As these accidents, deaths and illnesses cause costs for the capitalist system and for the States, then investment becomes necessary. Here the standardization processes come in to safeguard the lives of workers, but what results is the negligence of the system in cases of accident and death.

There is a risk of killing and maiming, without legal and social penalties for these deaths and mutilations. The work environments also follow this logic, as the level of unhealthy and dangerous on the factory floor is much higher than in the office. Control over ergonomic, chemical, physical, and biological aspects is much greater in the office than on the factory floor. Although the actions in health and safety at work are, for the most part, focused on the factory floor, perhaps due to the greatest risks, they are still exercised from top to bottom, without the knowledge of the real work performed. This creates a gap between the norm and real work, which sets the precedent for accidents, deaths, and illnesses to continue happening and existing.

For this reason, reflect on biopolitics or this qualified life or the processes of social inequality that one can have health and safety at work actions really concerned with human lives. This will generate more effective contributions to International Health Security. Life needs to stop being politically appropriate. Life needs to return to being just a condition of the subject's existence. It is necessary to have respect and responsibility toward individuals in a society. Only in this way can one think about how to adapt work processes and work organization to the human conditions of the worker. As long as these inequalities and hierarchies are not recognized, the prescribed work will have a central role, since it excepts responsibilities, leaving real work at the mercy of its conditions of production and the fate of destiny.


Author details

Mendes Luciano

Luiz de Queiroz College of Agriculture, University of São Paulo,
Piracicaba, São Paulo, Brazil

*Address all correspondence to: mendes@usp.br

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Hofmann DA, Burke MJ, Zohar D. 100 years of occupational safety research: From basic protections and work analysis to a multilevel view of workplace safety and risk. *Journal of Applied Psychology*. 2017;**102**(3):375. DOI: 10.1037/apl0000114
- [2] Szreter S. Economic growth, disruption, deprivation, disease, and death: On the importance of the politics of public health for development. *Population and development review*. 1997;**693**:1-728. DOI: 10.2307/2137377
- [3] Rodgers G, Lee E, Swepston L, Van Daele J. *The International Labour Organization and the quest for social justice*, London. 1919-2009. 2009. DOI: 10.1111/j.1467-8543.2011.00879_6.x
- [4] Gauvain S, Schilling RSF. Education in Occupational Health. In: Schilling RSF, editor. *Occupational Health Practice*. Butterworth-Heinemann, London. 1973. pp. 431-450. DOI: 10.1016/B978-0-407-33700-8.50029-2
- [5] Quinlan M. The toll from toil does matter: Occupational health and labour history. *Labour History: A Journal of Labour and Social History*. 1997;**73**:1-29. DOI: 10.3828/27516499
- [6] Reich MR, Goldman RH. Italian occupational health: Concepts, conflicts, implications. *American Journal of Public Health*. 1984;**74**(9):1031-1041. DOI: 10.2105/AJPH.74.9.1031
- [7] Liu K. Regulating health and safety at the workplace: Prescriptive approach vs goal-oriented approach. *Safety Science*. 2019;**120**:950-961. DOI: 10.1016/j.ssci.2019.08.034
- [8] LaDou J. *A World of False Promises: International Labour Organization, World Health Organization, and the Plea of Workers Under Neoliberalism*. International Journal of Health Services. 2020;**917**:1-942. DOI: 10.1177/0020731420917912
- [9] Pouliakas K, Theodossiou I. The economics of health and safety at work: An interdisciplinary review of the theory and policy. *Journal of Economic Surveys*. 2013;**27**(1):167-208. DOI: 10.1111/j.1467-6419.2011.00699.x
- [10] Mendes L, Dos Santos HB, Ichikawa EY. Health and safety at work: Analysis from the Brazilian documentary film flesh and bone. *Safety and Health at Work*. 2017;**8**(4):347-355. DOI: 10.1016/j.shaw.2017.01.003
- [11] Powell RR. Recent trends in research: A methodological essay. *Library & Information Science Research*. 1999;**21**(1):91-119. DOI: 10.1016/S0740-8188(99)80007-3
- [12] Grawitch MJ, Gottschalk M, Munz DC. The path to a healthy workplace: A critical review linking healthy workplace practices, employee well-being, and organizational improvements. *Consulting Psychology Journal: Practice and Research*. 2006;**58**(3):129-145. DOI: 10.1037/1065-9293.58.3.129
- [13] Kortum E, Leka S, Cox T. Psychosocial risks and work-related stress in developing countries: Health impact, priorities, barriers and solutions. *International Journal of Occupational Medicine and Environmental Health*. 2010;**23**(3):225-238. DOI: 10.2478/v10001-010-0024-5
- [14] Pransky G, Snyder T, Dembe A, Himmelstein J. Under-reporting of work-related disorders in the workplace: A case study and review of the literature. *Ergonomics*. 1999;**42**(1):171-182. DOI: 10.1080/001401399185874

- [15] Dwyer T, Raftery AE. Industrial accidents are produced by social relations of work: A sociological theory of industrial accidents. *Applied Ergonomics*. 1991;**22**(3):167-178. DOI: 10.1016/0003-6870(91)90156-C
- [16] Adler PS, Goldoftas B, Levine DI. Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science*. 1999;**10**(1):43-68. DOI: 10.1287/orsc.10.1.43
- [17] Aneziris ON, Topali E, Papazoglou IA. Occupational risk of building construction. *Reliability Engineering & System Safety*. 2012;**105**:36-46. DOI: 10.1016/j.res.2011.11.003
- [18] Montmayeul R, Mosneron-Dupin F, Llory M. The managerial dilemma between the prescribed tasks and the real activity of operators: Some trends for research on human factors. *Reliability Engineering and System Safety*. 1994;**45**(1-2):67-73. DOI: 10.1016/0951-8320(94)90077-9
- [19] Marhavilas PK, Koulouriotis D, Gemeni V. Risk analysis and assessment methodologies in the work sites: On a review, classification and comparative study of the scientific literature of the period 2000-2009. *Journal of Loss Prevention in the Process Industries*. 2011;**24**(5):477-523. DOI: 10.1016/j.jlp.2011.03.004
- [20] Gunningham N. Negotiated non-compliance: A case study of regulatory failure. *Law & Policy*. 1987;**9**:69. DOI: 10.1111/j.1467-9930.1987.tb00398.x
- [21] Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and illness in the United States: Estimates of costs, morbidity, and mortality. *Archives of Internal Medicine*. 1997;**157**(14):1557-1568. DOI: 10.1001/archinte.1997.00440350063006
- [22] Jallon R, Imbeau D, Marcellis-Warin N. Development of an indirect-cost calculation model suitable for workplace use. *Journal of Safety Research*. 2011;**42**(3):149-164. DOI: 10.1016/j.jsr.2011.05.006
- [23] Erwin S. Political technique, the conflict of umori, and Foucault's reading of Machiavelli in *Sécurité, Territoire, Population*. *Foucault Studies*. 2015:172-190. DOI: 10.22439/fs.v0i19.4829
- [24] Evans B, Reid J. Dangerously exposed: The life and death of the resilient subject. *Resilience*. 2013;**1**(2):83-98. DOI: 10.1080/21693293.2013.770703
- [25] Rabinow P, Rose N. Biopower today. *BioSocieties*. 2006;**1**(2):195-217. DOI: 10.1017/S1745855206040014
- [26] Legg S. Foucault's population geographies: Classifications, biopolitics and governmental spaces. *Population, Space and Place*. 2005;**11**(3):137-156. DOI: 10.1002/psp.357
- [27] Debrix F, Barder AD. Nothing to fear but fear: Governmentality and the biopolitical production of terror. *International Political Sociology*. 2009;**3**(4):398-413. DOI: 10.1111/j.1749-5687.2009.00083.x
- [28] Fassin D. Another politics of life is possible. *Theory, Culture and Society*. 2009;**26**(5):44-60. DOI: 10.1177/0263276409106349
- [29] Sheth FA. The war on terror and ontopolitics: Concerns with Foucault's account of race, power sovereignty. *Foucault Studies*. 2011;**12**:51:-76. DOI: 10.22439/fs.v0i12.3337
- [30] Savage R. "Disease incarnate": Biopolitical discourse and genocidal dehumanisation in the age of modernity. *Journal of Historical*

Sociology. 2007;**20**(3):404-440. DOI:
10.1111/j.1467-6443.2007.00315.x

[31] Behrent MC. Accidents happen: François Ewald, the “antirevolutionary” Foucault, and the intellectual politics of the French Welfare State. *The Journal of Modern History*. 2010;**82**(3):585-624. DOI: 10.1086/653042

[32] Fleming P. When ‘life itself’ goes to work: Reviewing shifts in organizational life through the lens of biopower. *Human Relations*. 2014;**67**-7:875-901. DOI: 10.1177/0018726713508142

[33] Dubreuil L, Eagle CC. Leaving politics: Bios, zōē, life. *Diacritics*. 2006;**36**-2:83-98. DOI: 10.1353/dia.2008.0013

[34] Fingarette H. Insanity and responsibility. *Inquiry*. 1972;**15**-4:6-29. DOI: 10.1080/00201747208601655

[35] Finlayson JG. “Bare life” and politics in Agamben’s reading of Aristotle. *The Review of Politics*. 2010;**72**(1):97-126. DOI: 10.1017/S0034670509990982

[36] Murray SJ. Thanatopolitics: Reading in Agamben a rejoinder to biopolitical life. *Communication and Critical/Cultural Studies*. 2008;**5**(2):203-207. DOI: 10.1080/14791420802024350

[37] Prozorov S. Living à la mode: Form-of-life and democratic biopolitics in Giorgio Agamben’s *The Use of Bodies*. *Philosophy & Social Criticism*. 2017;**43**(2):144-163. DOI: 10.1177/0191453716662500

*Edited by Stanislaw P. Stawicki,
Michael S. Firstenberg, Sagar C. Galwankar,
Ricardo Izurieta and Thomas Papadimos*

International health security (IHS) is a broad and highly heterogeneous area. Within this general context, IHS encompasses subdomains that potentially influence (and more specifically endanger) the well-being and wellness of humans. The general umbrella of IHS includes, but is not limited to, natural disasters, emerging infectious diseases (EID) and pandemics, rapid urbanization, social determinants of health, population growth, systemic racism and discrimination, environmental matters, civilian violence and warfare, various forms of terrorism, misuse of antibiotics, and the misuse of social media. The need for this expanded definition of health security stems from the realization that topics such as EID; food, water, and pharmaceutical supply chain safety; medical and health information cybersecurity; and bioterrorism, although important within the overall realm of health security, are not only able to actively modulate the wellness and health of human populations, but also tend to do so in a synergistic fashion. This inaugural tome of a multi-volume collection, *Contemporary Developments and Perspectives in International Health Security*, introduces many of the topics directly relevant to modern IHS theory and practice. This first volume provides a solid foundation for future installments of this important and relevant book series.

Published in London, UK

© 2021 IntechOpen
© akinshin / iStock

IntechOpen

