

# **SpringerBriefs in Bioengineering**

SpringerBriefs present concise summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50 to 125 pages, the series covers a range of content from professional to academic. Typical topics might include: A timely report of state-of-the art analytical techniques, a bridge between new research results, as published in journal articles, and a contextual literature review, a snapshot of a hot or emerging topic, an in-depth case study, a presentation of core concepts that students must understand in order to make independent contributions.

More information about this series at <http://www.springer.com/series/10280>

Krish W. Ramadurai • Sujata K. Bhatia

# Reimagining Innovation in Humanitarian Medicine

Engineering Care to Improve Health  
and Welfare

 Springer

Krish W. Ramadurai  
Massachusetts Institute of Technology  
Cambridge, MA, USA

Sujata K. Bhatia  
Chemical & Biomolecular Engineering  
University of Delaware  
Newark, DE, USA

ISSN 2193-097X ISSN 2193-0988 (electronic)  
SpringerBriefs in Bioengineering  
ISBN 978-3-030-03284-5 ISBN 978-3-030-03285-2 (eBook)  
<https://doi.org/10.1007/978-3-030-03285-2>

Library of Congress Control Number: 2018961402

© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2019

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*To the victims of humanitarian crises and  
conflict...you are not alone.*

*And to my parents and family, here's to  
making the world a better place.*

*– Kris*

*For Calestous—our dear friend, mentor, and  
colleague.*

*– Kris and Sujata*

# Preface

Take a look at our world today and what do you see? We could indeed answer this simple question by saying that we see a global population of 7.2 billion people, with each individual functioning as a contributing entity in the workings of our greater societies and civilizations. While indeed this macroscopic view depicts an orderly world, what happens when we look closer? When we peer into the inner workings and dynamics of our human population, we begin to see the effectors of inequalities and disparities. This is very much true when it comes to the relative health and wealth of various segments of our human population. Nearly half of the human population (3.6 billion) lives in objective poverty, living off of \$2.50 USD a day, and more than 1.3 billion people live in extreme poverty—less than \$1.25 USD a day. The notion of poverty is not just quantitative in nature but reflective of qualitative social components. Specifically, impoverished individuals are extremely susceptible and vulnerable to crises and conflict. Developing countries around the world that often harbor impoverished populations are generally host to weak supporting political, economic, social, and healthcare infrastructure and institutions. The fragility complex surrounding these weak supporting institutional elements in developing countries is why so many countries are so susceptible to catastrophic humanitarian emergencies and crises. But what do we mean by humanitarian emergencies and crises? A humanitarian emergency is an event or series of events that represents a critical threat to the health, safety, security, or well-being of a community or population. Our world has been host to a myriad of humanitarian emergencies ranging from the Somali famine in 1992 and Rwandan genocide in 1994 to the presently ongoing civil wars in Yemen and Syria.

From a global humanitarian perspective, more 125 million people around the world are in need of immediate humanitarian assistance and aid. While war, famine, displacement, political conflict/discourse, and natural disasters are most certainly detrimental to any population, these humanitarian crises are particularly devastating to the 50% of the global population that lives in poverty, the reason being that this population typically lacks access to fundamental resources such as food, shelter, and healthcare. This is further amplified in developing countries which often harbor highly volatile and fragile governments as well as weak economic and healthcare

systems. This culmination of weak supporting infrastructure and governing bodies coupled with subsistence living amplifies the gradient of any humanitarian crisis and emergency. But what is the fundamental defining element of the human condition in these crises? That would be the preservation of human health and dignity via humanitarian medicine and innovation. The goal of any humanitarian operation is to seek the preservation of human health by providing in-the-field care and support services via humanitarian aid workers and practitioners in order to save lives. Humanitarian medicine is made up of a wide range of practices including battlefield medicine and surgery, emergency teams in disaster situations, vaccination campaigns, and public health education. Humanitarian medicine is a core component of the humanitarian emergency relief and delivery paradigm, and it is important to note that the degree of humanitarian emergencies is not limited to a short-term time-frame. Oftentimes aid delivery is viewed as a short-term initiative, whereby the delivery of aid and assistance is provided with only immediate benefits and remedies in mind. Everyone seeks a “success story.” However, the fact is that the true depth of a humanitarian crisis sinks far deeper than many care to recognize, and the effects typically perpetuate and permeate society long into the future.

So how do we begin to remedy this? In this book, we focus on humanitarian innovation and fostering creative problem-solving to address humanity’s most pressing problems, specifically, the ability to redefine how practitioners and crisis-affected communities themselves can pool their intellectual capital together to enhance human health outcomes in the field. This includes enhancing the interventional capacities of humanitarian medical practitioners, aid workers, and the greater communities they serve from the ground up. We specifically seek to explore the intersection of various innovation paradigms—i.e., frugal, open, and reverse innovation—in fostering novel technologies and strategies that can serve to enhance healthcare support and delivery in crises. By redefining the humanitarian medicine paradigm through the application of feasible, utilitarian technologies, we can ultimately improve and save the lives of millions more people around the world. For it is in creating solutions to help our fellow man that the purest essence of innovation is derived.

Cambridge, MA, USA  
Newark, DE, USA

Krish W. Ramadurai  
Sujata K. Bhatia

# Abstract

Throughout our history, humanity has been plagued by a myriad of humanitarian crises that have opened the door to perpetual human suffering. This holds true in the present day, where approximately 125,000,000 people require humanitarian assistance as the result of famine, war, geopolitical conflict, and natural disasters. A core component related to human suffering experienced is that of afflictions related to human health. Each of these situations creates an impetus for morbidities and comorbidities that must be treated medically. Perhaps one of the most startling elements is that oftentimes life is lost to preventable medical conditions that were not properly treated or even diagnosed in the field. This is often due to the limited interventional capacity that medical teams and humanitarian practitioners have in these scenarios. These individuals are often hindered by medical equipment deficiencies or devices not meant to function in austere conditions. The essence of humanitarian medicine is to alleviate suffering, but the key to this strategy is to enhance the interventional capacities of humanitarian practitioners, particularly in the realm of healthcare delivery. The development of highly versatile, feasible, and cost-effective medical devices and technologies that can be deployed in the field is key to enhancing medical care in unconventional settings. But where do we begin? In this book we examine the nature of the creative problem-solving paradigm and dissect the intersection of frugal, disruptive, open, and reverse innovation processes in solving humanity's most pressing problems. We define the relative capacities of innovation processes in serving as an impetus for the engineering and development of novel technologies in redefining humanitarian medicine and aid relief. Specifically, we delve into the feasible deployment of these devices and technologies in unconventional environments not only by humanitarian agencies but also by crisis-affected communities themselves. We explore how to harness the power of various innovation processes to empower humanitarian practitioners in crisis situations as well as the very people and communities they serve. We explore this as well as the application of other innovations and technologies across multiple areas to radically improve humanitarian aid and disaster relief. In this book we take the complex challenge of developing innovative solutions for the delivery of humanitarian aid and medicine head on.

# Contents

<b>1</b>	<b>The Humanitarian Relief Paradigm</b> .....	<b>1</b>
1.1	Current Humanitarian Crises: Defining the Humanitarian Aid Complex .....	2
1.2	Medical Treatment in Unconventional Settings: Meeting the Needs of Conflict Victims .....	6
1.2.1	Health Is Wealth: Avoiding Chronic Illness as a Perpetuity .....	9
1.2.2	The Humanitarian Paradox: What Happens When We Leave? .....	12
1.3	Disparities of Healthcare Services in Conflict and Disaster Areas .....	14
1.4	Humanitarian Innovation and Frugal Engineering: A Social Perspective .....	19
	References .....	24
<b>2</b>	<b>Humanitarian Innovation + Medicine: Defining the Innovation Process</b> .....	<b>27</b>
2.1	Adapting Innovation Sub-types in Humanitarian Medicine: Turning the Unconventional into Conventional .....	28
2.2	Frugal Innovation Sub-Types in Health and Medicine .....	30
2.2.1	Contextualized Adaptations .....	30
2.2.2	Bottom-Up .....	33
2.2.3	Lean Tools and Techniques .....	34
2.2.4	Opportunistic Solutions .....	37
2.3	Disruptive Innovation: The Real Meaning .....	38
2.4	Open and Reverse Innovation + Crowdsourcing and Wikicapital: The Future of Creative Problem-Solving .....	40
	References .....	45

- 3 Frugal Medical Technologies and Adaptive Solutions:**
  - Field-Based Applications** . . . . . 49
  - 3.1 Enhancing the Interventional Capacity of Community Health Workers and Crisis-Stricken Communities . . . . . 50
  - 3.2 Scaling Adaptive Solutions in the Humanitarian Field . . . . . 54
    - 3.2.1 Surgical Care and Prosthetics . . . . . 54
    - 3.2.2 Maternal Conditions . . . . . 60
    - 3.2.3 Infectious Diseases . . . . . 65
  - References . . . . . 71
  
- 4 Disruptive Technologies and Innovations in Humanitarian Aid and Disaster Relief: An Integrative Approach** . . . . . 75
  - 4.1 Data Collection and Crisis Management: Crowdsourced Crisis Mapping . . . . . 75
  - 4.2 Robotics and Wearable Technology . . . . . 78
  - 4.3 mHealth, Telemedicine, and Blockchain . . . . . 84
  - References . . . . . 90
  
- 5 Humanitarian Innovation in the Modern Era:**
  - Ending Human Suffering** . . . . . 93
  - 5.1 Reworking Knowledge Transfer in the Humanitarian Ecosystem: Empowering Conflict Victim and Refugee Innovation . . . . . 94
  - 5.2 The Future of Humanitarian Medicine and Creative Problem-Solving . . . . . 100
  - References . . . . . 105