International Disaster Health Care

Preparedness, Response, Resource Management, and Education

Girish Bobby Kapur | Amado Alejandro Baéz
Editors

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About the Editors

Girish Bobby Kapur, MD, MPH

Girish Bobby Kapur, MD, MPH, is the Chief of Emergency Medicine at Jackson Memorial Hospital (JMH) in Miami, FL and was recruited in 2015 to bring transformative change in the delivery of high-quality acute patient care at one of the nation's busiest emergency centers. In addition, Dr. Kapur is launching an academic platform with his colleagues at JMH based on clinical excellence, innovative education, translational research, and public health outreach at the Jackson Health System and the University of Miami Miller School of Medicine. Dr. Kapur is an internationally recognized emergency physician and public health expert who previously served as the Associate Chief for Academic Affairs and the Founding Residency Program Director in the Section of Emergency Medicine and an Associate Professor of Medicine and Pediatrics at Baylor College of Medicine (BCM) from 2009-2015. Based on his international and academic accomplishments, Dr. Kapur was also appointed by BCM President Paul Klotman as the Founding Director of the Center for Globalization at Baylor College of Medicine. For two years, Dr. Kapur helped guide the College's global initiatives and worked with the BCM faculty, residents, and students to fulfill BCM's mission to be an international leader in academic medicine. In September 2014, Dr. Kapur led a six-person team that trained nearly 1,500 people in Ebola preparedness and response in Nigeria during the middle of the epidemic in the country. Dr. Kapur was also a co-investigator on the USAID grant "Fighting Ebola: A Grand Challenge" that was one of twelve grants awarded from over 1,500 submissions. Before his roles at BCM, Dr. Kapur directed global health training programs and international projects at the Ronald Reagan Institute for Emergency Medicine at George Washington University (GWU) from 2004-2009. At GWU, Dr. Kapur established multiple academic training programs and acute healthcare systems with partners in India, China, Latin America and the Middle East. In addition, Dr. Kapur implemented a countrywide project to improve emergency services in Turkey that trained more than 2,000 physicians providing emergency care in Turkey's national hospitals. Dr. Kapur received his Bachelor of Arts degree in English Literature and Policy Studies from Rice University and his Medical Doctor degree from Baylor College of Medicine.

He then completed his residency in Emergency Medicine from Yale School of Medicine followed by a fellowship in international emergency medicine and global health from Brigham and Women's Hospital and Harvard School of Medicine. He also completed his Master in Public Health from the Harvard School of Public Health. Dr. Kapur has published multiple peer-reviewed papers and is the senior editor for the first textbook in the field of Emergency Public Health titled Emergency Public Health: Preparedness and Response. Dr. Kapur has served as the Chair of the International Committee for both the American College of Emergency Physicians and the Society for Academic Emergency Medicine. In June 2012, Dr. Kapur was awarded the Order of the International Federation of Emergency Medicine for his contributions to global health and emergency medicine, an honor given to only two US emergency physicians every two years.

Amado Alejandro Baéz, MD, MSc, MPH, FAAEM, FCCP, FCCM

Amado Alejandro Baéz, MD, MSc, MPH, FAAEM, FCCP, FCCM, completed his residency in Emergency Medicine at the Mayo Clinic and a Fellowship in Trauma Critical Care at Harvard University/Brigham and Women's Hospital. He has masters degrees in Public Health and Health Care Management and Policy. Born in raised in the Dominican Republic since 1992, Dr Baez has been actively leading efforts in Prehospital and Disaster Medicine, serving as national Chief of Operation with the Dominican Red Cross, Consultant to the Pan-American Health organization and Security Operator and Advisor to the Dominican Government. Dr. Baéz has lectured in over a dozen countries and authored more than 100 publications and abstracts in the fields of disaster, tactical/operational, trauma, and critical care. From 2006 to 2009, he served as Associate Director for EMS at the Brigham and Women's Hospital/ Harvard, and from 2009 to 2005, he chaired an Academic Department of Emergency Medicine in the Dominican Republican, where he worked closely with the government, NGOs, and academia in operational medicine and disaster management solutions. Dr. Baéz was instrumental in leading efforts that resulted in a transborder system between Haiti and the Dominican Republic that cared for close to 5,000 victims and relatives of the 2010 earthquake. He currently serves as the Emergency Medicine Program Director Jackson Memorial Hospital. Previously, he was at the Operational Medicine Institute at Harvard Medical Faculty Physicians (founding director), Hospital General de la Plaza de la Salúd, Universidad Iberoamericana (UNIBE).

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Acknowledgments and How to Cite

The editors and publisher thank each of the authors who contributed to this book. The chapters in this book were previously published elsewhere, as indicated by the citation on each chapter opener. To cite the work contained in this book and to view the individual permissions, please refer to the citation at the beginning of each chapter. The editors carefully selected each chapter to create as complete as possible an image of the needs, concerns, and insights that relate to disaster preparedness from an international health-care perspective.

The chapters included are broken into five sections, which describe the following topics:

Part I is an overview of disaster-related health care:

- In chapter 1, the authors stress with great urgency that integrating disaster response into the health-care training and delivery system worldwide will have socioeconomic effects far beyond the individual lives saved.
- In chapter 2, the authors call for an evidence base to improve health care in disasters.

Part II looks at the issue from the perspectives of disaster preparedness and resilience:

- The authors of chapter 3 conclude that hospitals need to take a more cohesive approach to be resilient in order to position themselves to be able to best cope with a potential disaster.
- Chapter 4 looks specifically at the adaptive capacity of the health sector to disaster response in the climate change context in Pacific Island Countries.
- Chapter 5 offers a method for assessing emergency plans and provides baseline information that will be useful for ongoing planning efforts.

The article in Part III defines an effective medical response to disaster:

- In chapter 6, the authors make a strong call to providers of surgical health care in disaster settings to ensure that they use minimum standards of care before undertaking surgery and avoid more rigorous procedures when these standards cannot be met

Part IV focuses on ways to manage resources during a disaster:

- Chapter 7 examines the dilemmas providers confront during triage and allocation, and relates these to ethical issues.
- Chapter 8 categorizes relief from the point view of government and academia, and then explains the relationship between relief categorization and demand forecasting.
- Chapter 9 reports on a North Carolina model that contributed to the improved quality of public health preparedness and emergency operations plans and streamlined processes related to both emergency management and public health preparedness.

Part V looks at ways in which medical staff can be better educated to handle disasters:

- Chapter 10 lists recommendations made at a Council of Emergency Medicine conference to enhance the global health education of emergency medicine residents.
- In chapter 11, the authors share their experiences and lessons learned regarding the preparation of medical personnel for early response humanitarian aid delegations.
- Chapter 12 concludes that nurses should be adequately prepared with knowledge and skills for management of disasters, starting from their basic training and reinforcement in their on-the-job continuing training.
- Chapter 13 presents a consensus-based research agenda that highlights five priority research questions related to global health education at the undergraduate medical education level

Introduction

The United Nations has recognized the devastating consequences of "unpredictable, unpreventable and impersonal" disasters—at least US $2 trillion in economic damage and more than 1.3 million lives lost from natural disasters in the last two decades alone. In many disasters (both natural and man-made) hundreds—and in major earthquakes, thousands—of lives are lost in the first days following the event because of the lack of medical/surgical facilities to treat those with potentially survivable injuries. Disasters disrupt and destroy not only medical facilities in the disaster zone but also infrastructure (roads, airports, electricity) and potentially local healthcare personnel as well. To minimize morbidity and mortality from disasters, medical treatment must begin immediately, within minutes ideally, but certainly within 24 hours (not the days to weeks currently seen in medical response to disasters). This requires that all resources—medical equipment and support, and healthcare personnel—be portable and readily available; transport to the disaster site will usually require helicopters, as military medical response teams in developed countries have demonstrated. Some of the resources available and in development for immediate medical response for disasters—from portable CT scanners to telesurgical capabilities—are described in chapter 1. For immediate deployment, these resources—medical equipment and personnel—must be ready for deployment on a moment's notice and not require administrative approvals or bureaucratic authorizations from numerous national and international agencies, as is presently the case. Following the "trauma center/stroke center" model, disaster response incorporating "disaster response centers" would be seamlessly integrated into the ongoing daily health-care delivery systems worldwide, from medical education and specialty training (resident/registrar) to acute and subacute intensive care to long-term rehabilitation. The benefits of such a global disaster response network extend far beyond the lives saved: universal standards for medical education and healthcare delivery, as well as the global development of medical equipment and infrastructure, would follow. Capitalizing on the humanitarian nature of disaster response—with its suspension of the cultural, socioeconomic, and political barriers that often paralyze international cooperation and development—disaster

response can be predictable, loss of life can be preventable and benefits can be both personal and societal.

As for any type of health care, decisions about interventions in the context of natural disasters, conflict, and other major healthcare emergencies must be guided by the best possible evidence. Disaster health interventions and decision making can benefit from an evidence-based approach. Chapter 2 outlines how systematic reviews and methodologically sound research can build a much-needed evidence base. The authors do this from the standpoint of Evidence Aid, an initiative that aims to improve access to evidence on the effects of interventions, actions, and policies before, during, and after disasters and other humanitarian emergencies, so as to improve health-related outcomes.

Hospital disaster resilience can be defined as a hospital's ability to resist, absorb, and respond to the shock of disasters while maintaining critical functions, and then to recover to its original state or adapt to a new one. Chapter 3 aims to explore the status of resilience among tertiary hospitals in Shandong Province, China. A stratified random sample (n = 50) was derived from tertiary A, tertiary B, and tertiary C hospitals in Shandong Province, and was surveyed by questionnaire. Data on hospital characteristics and 8 key domains of hospital resilience were collected and analyzed. Variables were binary, and analyzed using descriptive statistics such as frequencies. A response rate of 82% (n = 41) was attained. Factor analysis identified four key factors from eight domains that appear to reflect the overall level of disaster resilience. These were hospital safety, disaster management mechanisms, disaster resources and disaster medical care capability. The survey demonstrated that in regard to hospital safety, 93% had syndromic surveillance systems for infectious diseases and 68% had evaluated their safety standards. In regard to disaster management mechanisms, all had general plans, while only 20% had specific plans for individual hazards. 49% had a public communication protocol and 43.9% attended the local coordination meetings. In regard to disaster resources, 75.6% and 87.5% stockpiled emergency drugs and materials respectively, while less than a third (30%) had a signed Memorandum of Understanding with other hospitals to share these resources. Finally in regard to medical care, 66% could dispatch an on-site medical rescue team, but only 5% had a "portable hospital" function and 36.6% and 12% of the hospitals could surge their beds and staff capacity respectively. The average beds surge capacity within 1 day was 13%. This study validated the broad utility of a framework for understanding and measuring the level of hospital resilience. The survey demonstrated considerable variability in disaster resilience arrangements

of tertiary hospitals in Shandong province, and the difference between tertiary A hospitals and tertiary B hospitals was also identified in essential areas.

There is a growing body of evidence that the impacts of climate change are affecting population health negatively. The Pacific region is particularly vulnerable to climate change; a strong health-care system is required to respond during times of disaster. Chapter 4 examines the capacity of the health sector in Pacific Island Countries to adapt to changing disaster response needs, in terms of: (i) health workforce governance, management, policy and involvement; (ii) health-care capacity and skills; and (iii) human resources for health training and workforce development. Key stakeholder interviews informed the assessment of the capacity of the health sector and disaster response organizations in Pacific Island Countries to adapt to disaster response needs under a changing climate. The research specifically drew upon and examined the adaptive capacity of individual organizations and the broader system of disaster response in four case study countries (Fiji, Cook Islands, Vanuatu and Samoa). "Capacity" including health-care capacity was one of the objective determinants identified as most significant in influencing the adaptive capacity of disaster response systems in the Pacific. The research identified several elements that could support the adaptive capacity of the health sector such as: inclusive involvement in disaster coordination; policies in place for health workforce coordination; belief in their abilities; and strong donor support. Factors constraining adaptive capacity included: weak coordination of international health personnel; lack of policies to address health worker welfare; limited human resources and material resources; shortages of personnel to deal with psychosocial needs; inadequate skills in field triage and counseling; and limited capacity for training. Findings from this study can be used to inform the development of human resources for health policies and strategic plans, and to support the development of a coordinated and collaborative approach to disaster response training across the Pacific and other developing contexts. This study also provides an overview of health-care capacity and some of the challenges and strengths that can inform future development work by humanitarian organizations, regional and international donors involved in climate change adaptation, and disaster risk reduction in the Pacific region.

The aim of chapter 5 is to carry out an audit of healthcare plans in New Zealand and Oman. Methods. The study utilizes a deductive content analysis method. Written plans from New Zealand District Health Boards (DHBs) and the Omani secondary and tertiary hospitals were analyzed. A checklist was used to score the plans against twelve elements that are command and control,

hazard analysis, surge capability, communication, standard operating procedures (SOPs), life-line backups, public and media, training, welfare, coordination, and recovery. There were 14 plans from New Zealand and 7 plans from Oman analyzed. The overall coverage of New Zealand plans was 67.5% compared to 53.3% in Oman. Plans from both countries scored similarly in "command and control," "hazard analysis," "surge," and "communication" elements. Omani plans scored lower than those of New Zealand in "media and the public," "training," "coordination," and "recovery." Both countries scored very low in addressing the welfare of responders. This study highlighted the value of health emergency plans in New Zealand as reflected by the high score of DHBs' coordination. Therefore, a similar approach in Oman will enhance emergency preparedness. Responders' welfare is an issue that needs to be addressed by emergency preparedness plans in both countries.

Scarce medical resources during a natural disaster challenge the existing protocols for medical intervention. Triage decisions about which patient to care for can be extremely stressful for a medical team. The case analysis in chapter 6 describes the experience of one mobile field hospital in Haiti in the aftermath of the January 12, 2010 earthquake. The medical team was confronted with the need to choose which of three critically ill patients should receive the remaining, dwindling oxygen supply. The ethical framework around these decisions is discussed. The development of an onsite ethics committee from team members is suggested to help lighten the burden of decision making off of the individual care provider.

Demand forecasting on relief is the premise and basis of material allocation scheme in emergency logistic system. Reasonable demand forecasting method can facilitate relief distribution, thus avoiding the phenomenon that supply-demand imbalance and relief distribution delay. In chapter 7, relief will be categorized from point view of government and academia, to explain the relationship between relief categorization and demand forecasting. The authors then introduce the characteristics of relief-demand from several aspects, such as sudden, uncertainty, timeliness, and stage. Finally, this chapter gives an overall conclusion on current development of relief-demand forecasting method. It also elaborates the application of case-based reasoning and information entropy theory, considering safety stock in the field of relief-demand forecasting in detail, to provide reference for relief distribution.

Some jurisdictions have reduced workforce and reallocated responsibilities for public health preparedness and emergency management to more efficiently

use resources and improve planning and response. In chapter 8, key informant interviews were conducted in six counties in North Carolina (USA) to discuss perceptions of the challenges and opportunities provided by the new shared positions. Respondents felt that planning and response have improved, but that requirements related to activities or equipment that are eligible for funding (particularly on the public health side) can present an impediment to consolidating public health preparedness and emergency management roles. As the financial resources available for public health preparedness and emergency management continue to be reduced, the merging of the roles and responsibilities of public health preparedness and emergency management may present jurisdictions with an effective alternative to reducing staff, and potentially, readiness.

An increasing number of emergency medicine (EM) residency training programs have residents interested in participating in clinical rotations in other countries. However, the policies that each individual training program applies to this process are different. The authors of chapter 9 state that little has been done in the standardization of these experiences to help EM residency programs with the evaluation, administration and implementation of a successful global health clinical elective experience. The objective of chapter 10's project was to assess the current status of EM global health electives at residency training programs and to establish recommendations from educators in EM on the best methodology to implement successful global health electives. During the 2011 Council of Emergency Medicine Residency Directors (CORD) Academic Assembly, participants met to address this issue in a mediated discussion session and working group. Session participants examined data previously obtained via the CORD online list serve, discussed best practices in global health applications, evaluations and partnerships, and explored possible solutions to some of the challenges. In addition a survey was sent to CORD members prior to the 2011 Academic Assembly to evaluate the resources and processes for EM residents' global experiences. Recommendations included creating a global health working group within the organization, optimizing a clearinghouse of elective opportunities for residents and standardizing elective application materials, site evaluations and resident assessment/feedback methods. The survey showed that 71.4% of respondents have global health partnerships and electives. However, only 36.7% of programs require pre-departure training, and only 20% have formal competency requirements for these global health electives. A large number of EM training programs have global health experiences available, but

these electives and the trainees may benefit from additional institutional support and formalized structure.

Humanitarian aid provision and early medical response missions to areas ravaged by natural disasters are as essential nowadays as in the past, and medical personnel play a pivotal role in these delegations. In November 2013, tropical cyclone Haiyan (Yolanda) slammed the Philippines archipelago, leaving more than an estimated 6000 dead in its wake while demolishing vital infrastructure and affecting the life of an estimated 25 million locals. The Israeli Defense Forces (IDF) rapidly constructed and sent a humanitarian aid delegation, which included a field hospital deployment with medical capabilities from diverse specialty fields. The purpose of chapter 10 is to summarize the authors' experience in the preparation process of medical personnel before and during deployment. They offer a simple, practical and structured checklist that will assist medical specialists in preparation for their missions. Preparation of medical personnel for humanitarian aid medical missions is a complex and vital task that might be better accomplished with thorough briefing and structured checklists that begin with addressing of personal safety and other daily needs of the staff.

Chapter 11 explores Hong Kong nurses' perceptions of competencies required for disaster nursing. Focus group interviews and written inquiry were adopted to solicit nurses' perceived required competencies for disaster care. A total of 15 nurses were interviewed and 30 nurses completed the written inquiry on their perceived competencies related to disaster nursing. The International Council for Nurses' (ICN) framework of disaster nursing competencies, consisting of four themes and ten domains, was used to tabulate the perceived competencies for disaster nursing reported by nurses. The most-mentioned required competencies were related to disaster response; with the ethical and legal competencies for disaster nursing were mostly neglected by nurses in Hong Kong. With the complexity nature of disasters, special competencies are required if nurses are to deal with adverse happenings in their serving community. Nurses' perceived disaster nursing competencies reported by nurses were grossly inadequate, demonstrating the needs to develop a comprehensive curriculum for public health. The establishment of a set of tailor-made disaster nursing core competencies for the community they served is the first step in preparing nurses to deal with disastrous situations for the health of the public.

Global emergency medicine is a rapidly growing field within EM, as evidenced by the increasing number of medical students desiring global health and emergency care experiences. Despite this growing popularity, little is known of

the effect of undergraduate medical education in global health on learners and patients in the United States and abroad. During the 2013 Academic Emergency Medicine consensus conference, a group of leading medical school educators convened to generate a research agenda on priority questions to be answered in this arena. This consensus-based research agenda is presented in this compendium's final chapter.

PART I
Overview

CHAPTER 1

Unpredictable, Unpreventable and Impersonal Medicine: Global Disaster Response in the 21st Century

Russell J. Andrews and Leonidas M. Quintana

1.1 PROBLEMS WITH CURRENT DISASTER RESPONSE

Disasters—largely unpredictable, unpreventable and impersonal—take a devastating toll around the world. Since the start of the new millennium, earthquakes alone have claimed upwards of 300,000 lives in each of 2 years (2004 and 2010) and upwards of 100,000 lives in each of 2 more years (2005 and 2008). Cyclones/hurricanes/typhoons claimed upwards of 150,000 lives in 2008, the majority due to Cyclone Nargis, which struck Myanmar (Burma) with approximately 140,000 lives lost [1,2].

The impact of natural disasters is substantial, in terms of both economic losses as well as lives lost. The trends for both economic losses and loss of life for the period 1956 through 2005 are graphed by decade in Figure 1.1. Hydrometeorological causes (notably cyclones/hurricanes/ typhoons) have inflicted increasing economic losses (approaching 500 billion USD for the decade 1996–2005), while geological causes (notably earthquakes) have

caused increasing numbers of deaths (well over 500,000 for the decade 1996–2005) [3].

The United Nations (UN) has recognized the impact of natural disasters worldwide. In the two decades following the Earth Summit in Rio de Janeiro in 1992, it has been estimated that the damages incurred totaled US $2 trillion and that the number of lives lost was greater than 1.3 million [4]. Following the Indian Ocean earthquake and tsunami that killed upwards of 300,000 people in 2004, the UN World Conference on Disaster Reduction (January, 2005, Kobe, Japan) noted the following [5]:

> "We have the knowledge for disaster reduction, what we need is the action. The most important condition for disaster reduction is the political commitment to remove the institutional barriers and integrate disaster risk reduction in the strategies and programmes for sustainable development..."

> "We recognize...the importance of involving all stakeholders, including governments, regional and international organizations and financial institutions, civil society, including non-governmental organizations and volunteers, the private sector and the scientific community" [5].

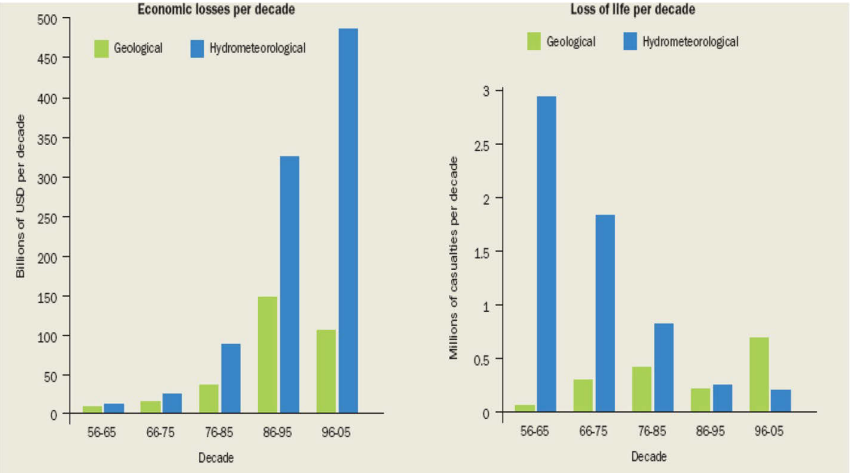

FIGURE 1.1 Economic losses and loss of life from hydrometeorological and geological disasters by decade (from reference [3] with permission).

One way to reduce the number of deaths in disasters is to get the medical/surgical "boots on the ground" at a disaster site before the injured have died of potentially survivable injuries. The most dramatic example in recent disasters is the Haiti earthquake of 2010. The Executive Director of Partners for Health, Ophelia Dahl, estimated that upwards of 20,000 people with survivable injuries died every day the first week following the Haiti earthquake because there were no surgical facilities available (to treat fractures, blunt and penetrating trauma, head injuries, etc.) [6]. It is informative that the first and only such international medical response team with surgical capabilities to arrive in Port-au-Prince within 24 h was the Icelandic Association for Search and Rescue, a group always ready for immediate deployment [7].

Why has disaster response been so ineffective in saving those victims with survivable injuries? Some reasons are the following:

1. Disasters typically are relatively rare occurrences in any specific location. Unlike the medical problems addressed by the healthcare system on a day-to-day basis—from chronic diseases such as diabetes, obesity and hypertension to acute events such as pregnancy, motor vehicle injuries and strokes—unless one lives in an earthquake-prone area (e.g. Japan, Chile) or a cyclone/hurricane/typhoon-prone area (e.g. the Caribbean, the Western Pacific), one is unlikely to experience a major disaster on more than a very occasional basis. Healthcare resources are likely to be spent on more frequent (if relatively benign) events such as the common cold, urinary tract infections and pneumonia than on very rare (but usually fatal) events such as Jacob-Creutzfeldt disease, cardiac arrest and the Ebola virus (apart from episodes like the current Ebola crisis).
2. Disasters are usually unpredictable. It is difficult to commit resources to an adverse event that occurs rarely and (given our lack of understanding of the aetiology) seemingly randomly. In the traditional healthcare system, there is, for example, more "bang for the buck" in maternal prenatal care than in screening the population for potential sudden cardiac arrest.
3. Disasters by their very nature evoke a humanitarian response. This falls outside the typical definition of a government's responsibility to its citizens (security, education, basic health care etc.). Because disasters are unpredictable and unpreventable, they fall "between the cracks" of traditional government agencies. The responsibility for disaster response is often delegated—perhaps "relegated" is more accurate—to religious and/or non-governmental groups (e.g. the Red Cross and Red Crescent, Médecins Sans Frontières).

4. Finally—but likely most importantly—disaster response as currently configured requires the coordination of various government agencies in order to be implemented. The time required for administrative approvals to initiate a disaster response when multiple agencies are involved is incompatible with saving the lives of those who have suffered survivable injuries but who require prompt (i.e. within hours, not days or weeks) medical care.

International organizations such as the UN and the World Health Organization (WHO) not only have documented the high cost of disasters—both in economic terms and in lives lost, as noted above—but also have created a multitude of agencies to react to disasters. The United Nations Strategy for Disaster Reduction (UNISDR)—just one of several UN agencies charged with disaster response—has a considerable bureaucracy as evidenced in Figure 1.2 [8].

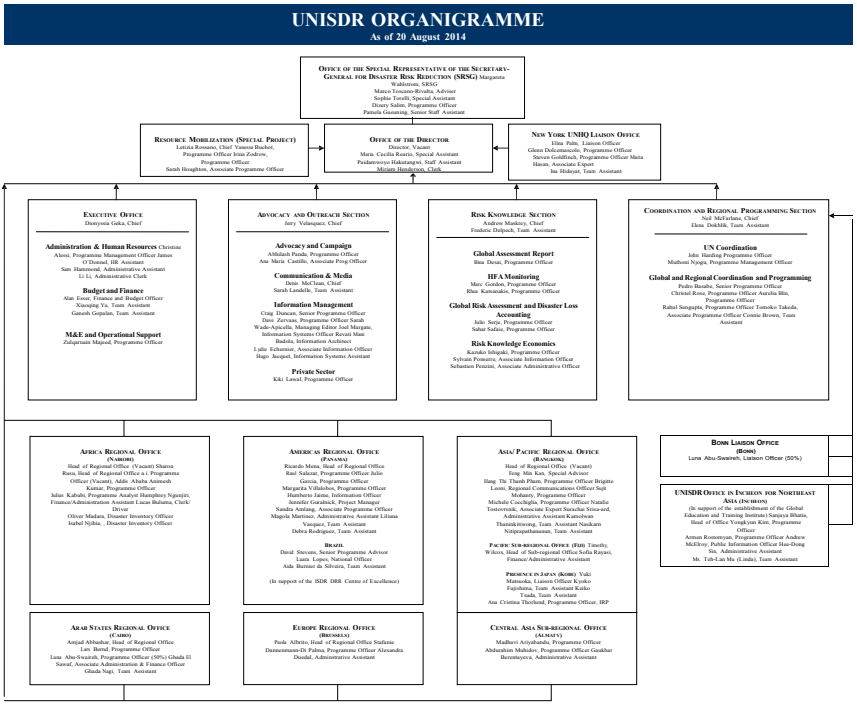

FIGURE 1.2 Organizational chart for the UN International Strategy for Disaster Reduction (from reference [8] with permission). Natural hazards impact trends.

The WHO timeline for disaster response, which consists of 23 performance standards, highlights the problem with the current procedures for disaster response. It is not until day 3 (performance standard 7) that "the arrival in-country of a team of experienced professionals" is expected. Moreover, the WHO performance standards are concerned almost exclusively with administrative not medical issues and the timely production of reports rather than the timely saving of lives [9].

An example of administrative bureaucracy paralyzing disaster response comes from Japan (which likely has one of the most robust disaster response programs). In early 2011—before the Fukushima earthquake and tsunami—the Japanese Air Self Defense Force (JASDF) had created what was essentially a three-bed mobile intensive care unit (the Aeromedical Evacuation Squadron—AMES), specifically for events such as the Fukushima disaster. Ironically, between April 2011 and April 2014, the AMES unit was used on only ten occasions. All of these ten missions involved the transport of a single patient (not the three patients the AMES is capable of transporting), none of whom was a disaster victim: the diagnoses ranged from hepatorenal failure to acute cardiac conditions. The reasons cited by members of the JASDF for the failure to use the AMES in disaster response included the following [10]:

1. The prefecture government's "name recognition" of the AMES availability for disaster response was low.
2. The prefecture government was unable to notify JASDF of the need for the AMES in a timely manner.
3. The need for the JASDF to provide supplies to the disaster site was a higher priority than the use of the AMES for transport of critically injured patients.

Another organization that has provided extensive disaster response in the Asia-Pacific region is the Australian Defense Force Air Medical Evacuation group (ADF AME). Based on over a decade of disaster response missions, the ADF AME suggested the following improvements are needed [11]:

1. A "short notice to move" structure is needed, i.e. rather than responding to each disaster with a "mission", the AME needs to have an ongoing system in place for immediate deployment.
2. The ADF should be integrated seamlessly with civilian resources for disaster response.

3. Multinational forums and agreements are needed to bring about regional integration of the disaster response teams amongst the various countries in the Asia-Pacific region.

1.2 DISASTER RESPONSE—THE GOOD, THE BAD AND THE OPPORTUNITY

On August 4, 2010—less than 6 months after the devastating earthquake and tsunami that struck south-central Chile—a man-made disaster struck northern Chile: the Copiapó mining accident. Thirty-three miners were trapped 2,300 feet below the surface in the San José copper-gold mine. Seventeen days after the accident, it was discovered that the 33 miners were in fact alive in an underground shelter. The Chilean government's response included the rapid mobilization of the following resources: virtually every Chilean government ministry, three international drilling rig teams and more than a dozen multinational corporations, as well as the US National Aeronautics and Space Administration (NASA). On October 13, 2010—more than 2 months after the accident—this global rescue effort safely rescued all 33 miners [12].

The comparison of the loss of life from recent cyclones/ typhoons in south and southeast Asia is also informative (Table 1.1). With cyclones/hurricanes/ typhoons and similar meteorological disasters, there is—fortunately—more advanced warning than with geological disasters such as earthquakes and volcano eruptions. In Cyclone Nargis, nearly 140,000 lives were lost; in Typhoon Haiyan 7,000; and in Cyclone Phailin, less than 50.

TABLE 1.1 Comparison of recent cyclones/typhoons in South and Southeast Asia

Name	Country	Date	Maximum wind speed (km/h)	Estimated deaths
Nargis	Myanmar	April 2008	215	~140,000
Phailin	India	October 2013	260	<50
Haiyan	Philippines	November 2013	315	~7,000

Estimated deaths from three recent cyclones/typhoons (from references [13-15] with permission).

What can account for the very high loss of life in Cyclone Nargis and the very low loss of life in Cyclone Phailin? Likely factors in Cyclone Nargis were the failure of the government to provide adequate warning and evacuation of those living in the Irrawaddy Delta, as well as the government's failure in the early days

following Cyclone Nargis to allow international assistance to participate in the disaster response. In Cyclone Phailin, likely the primary reason for relatively little loss of life was the establishment in the Indian state of Odisha of 31 telemedicine stations that very effectively coordinated a heroic evacuation effort: upwards of 1.3 million people were moved to 600 storm shelters. The system for disaster response was already in place and not dependent on the approvals and coordination of various agencies for the response to be implemented.

Although disasters can be devastating, the devastation can be reduced dramatically by effective planning and immediate initiation of the disaster response—as demonstrated by the governments of Chile and India in the examples above. The fact that disasters do not respect the borders between countries, the political differences between governments and the socioeconomic, cultural and religious differences amongst people make disaster response a unique opportunity to improve health care beyond merely reducing the morbidity and mortality of disasters. The need to respond immediately to a disaster eliminates the time for consideration of reasons why one should not do what is right from a humanitarian and moral aspect.

1.3 DISASTER RESPONSE—REQUIREMENTS, RESOURCES AND TECHNIQUES

Whether natural (e.g. earthquakes, typhoons and tsunamis) or man-made such as terrorist events (e.g. bombings or biosabotage) and large-scale accidents (e.g. airplane crashes or collapsed buildings), disasters not only physically damage large numbers of individuals, but they also damage or destroy the medical infrastructure in the region affected by the disaster. A surgeon without basic imaging/laboratory/blood bank, an operating room and support staff is useless. Not only are medical personnel needed (note that medical personnel in the disaster zone are not themselves immune from incapacitation or death from the disaster), but the medical facilities and infrastructure needed to run the operating room must also be imported.

Some of the equipment needs for disaster response include:

- operating rooms (including anesthesia, instruments, sterilization, imaging/laboratory/blood bank);
- electricity (generators);
- food and water;

- sanitation and accommodation for both personnel;
- and patients.

Some of the personnel needs for disaster response include:

- operating room staff (anesthesiologist, surgeon, nurses, support staff)
- infrastructure staff (imaging/laboratory/blood bank) – supply teams (transporters, likely helicopter in most situations and logistics)
- social service and rehabilitation (for postoperative care of patients).

In summary, not only are medical resources such as hospitals and doctors, and local infrastructure such as clean water and electricity, likely to be unavailable in a major disaster but the access routes for supplies (notably highways, railways and airports) are likely to be destroyed or unserviceable as well. One must be able to import all necessary resources, usually by helicopter.

Immediate response to medical emergencies has typically been the province of the military in most countries. In the USA, the US Army has developed the mobile emergency unit (MEU), a cargo container that—in various configurations—can serve as a self-contained operating room, recovery room and patient ward. Combined MEUs make up a combat support hospital, which parallels the civilian need for immediate medical resources in a disaster. The MEUs can be transported by helicopter (Figure 1.3). Other civilian non-governmental organizations such as the International Medical Corps (IMC) have similar self-contained transportable operating room facilities for disaster response.

FIGURE 1.3 Chinook transport helicopter—payload 12,000 kg; range 1,100 km.

The recent technological advances in portable medical equipment to support disaster response are impressive. Available presently are lightweight devices for the transport of liquid oxygen and its conversion to gaseous oxygen for patient use (Figure 4a), mass oxygen distribution systems for providing oxygen for up to 150 casualty patients simultaneously (Figure 1.4b) and liquid oxygen generators for use in harsh remote environments (Figure 1.4c). For patient monitoring and cardiac defibrillation, small, lightweight devices are available that—in addition to defibrillation—can simultaneously monitor a 12-lead electrocardiogram, noninvasive blood pressure, end-tidal CO_2, oxygen saturation, two temperature channels and three invasive pressures—with a 6-h battery life.

FIGURE 1.4 Lightweight devices for the transport of liquid oxygen and its conversion to gaseous oxygen for patient use. (a) 10-L Liquid Oxygen Converter (LOX)—full wt 20 kg—up to 8,600 L of gaseous oxygen (courtesy of Essex Industries, St. Louis, MO, USA). (b) Mass Oxygen (LOX) Distribution System (MODS)—up to 64,500 L of gaseous oxygen (courtesy of Essex Industries, St. Louis, MO, USA). (c) Oxygen Generator and Liquifier (OGL)—generates 1 L of LOX per hour; generated LOX can fill MODS (b) (courtesy of Essex Industries, St. Louis, MO, USA).

Computerized tomography (CT) scanning is crucial in the evaluation and treatment of trauma patients. A 400-kg portable head CT scanner (CereTom®) has been developed by NeuroLogica Corporation (Danvers, MA, USA, see Figure 1.5a). The CereTom CT scanner has all basic capabilities (contrast CT, CT angiography and xenon perfusion CT), can be easily moved on rollers by one person and can be powered by a 12-V car battery using an inverter. A larger but still portable version for body CT scanning (BodyTom®) is also available. Figure 1.5b, C illustrate the BodyTom CT scanner in both operational (Figure 1.5b) and transport mode in a containerized imaging room/operating room that can be airlifted to the disaster site (as shown in Figure 1.3). NeuroLogica Corporation has been acquired by Samsung Corporation, which should result in worldwide availability and support.

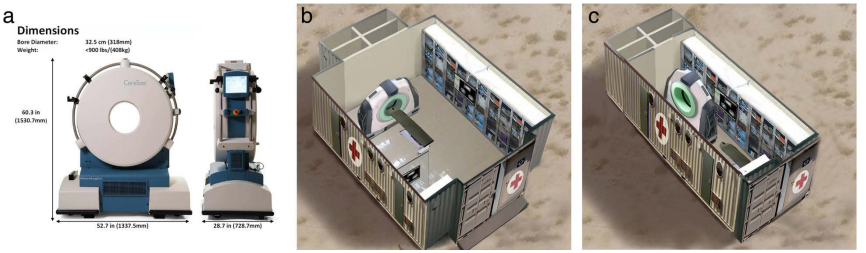

FIGURE 1.5 Computerized tomography scanning in the evaluation and treatment of trauma patients. (a) Ceretom portable head CT scanner—can run on car battery with inverter (courtesy of NeuroLogica, Danvers, MA, USA). (b) BodyTom portable CT scanner in operational mode (portable imaging/operating theatre) (courtesy of NeuroLogica, Danvers, MA, USA). (c) BodyTom portable CT scanner in transport mode (portable imaging/operating theatre) (courtesy of NeuroLogica, Danvers, MA, USA).

Frequently, the resource that is most difficult to have immediately at the site of a disaster is the medical/surgical specialist, such as a trauma surgeon, an orthopaedic surgeon or a neurosurgeon. Telesurgery allows the remotely located medical specialist to be "virtually" present at the disaster site. Surgical procedures unfamiliar to the "generalist" physician or the "first responder" emergency team at the disaster site can often be managed if the medical specialist (e.g. trauma surgeon) can act as a "virtual surgical assistant". Vigilent Telesystems (Dorval, QC, Canada), with the assistance of the Canadian Government, has created a remote-control camera system for providing real-time specialist guidance for physicians in remote clinics in northern Quebec (who may be 1,000 km or more from the nearest major medical center in Montreal or Quebec City). The telesystem consists of two remotely controlled robotic arms, each with a camera, which can be mounted on the ceiling of either a remote clinic or a portable operating room (MEU) (Figure 1.6a, b). A medical or surgical specialist, perhaps thousands of kilometres away, is able to control the cameras and interact verbally with the medical personnel at the disaster site, much as an attending surgeon might supervise a junior colleague in training. A portable, briefcase-sized, battery-powered, remotely controlled camera is being developed to allow continuous visual (vital sign etc.) monitoring of a trauma patient from the site of injury when the first responders arrive on the scene, in the ambulance or helicopter, to the trauma hospital and the operating room. The remotely located medical/surgical specialist could thus monitor and direct the care of a trauma patient from the scene of injury to definitive in-hospital treatment at either a medical center or a disaster response MEU. Such a portable remote monitoring device is functional wherever there is Internet access.

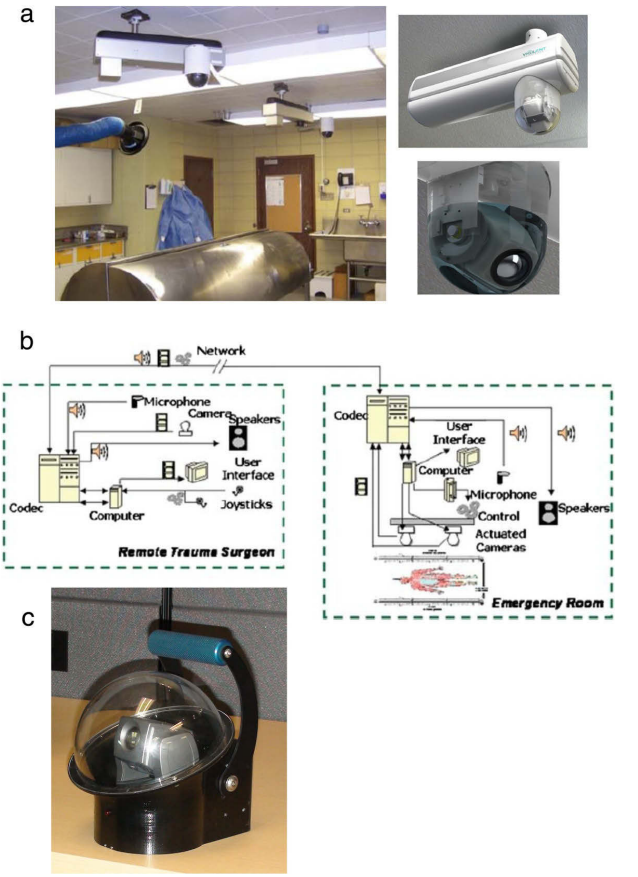

FIGURE 1.6 Remote-control camera system for providing real-time specialist guidance for physicians in remote clinics. (a) Top—overview of two ceiling-mounted remote-control cameras in emergency room. Bottom left—closeup of mobile arm + camera. Bottom right—closeup of mobile camera. (courtesy of Vigilent Telesystems, Dorval, QC, Canada). (b) Schematic of emergency room and remote trauma surgeon for "telesurgery" (courtesy of Vigilent Telesystems, Dorval, QC, Canada). (c) Photo of portable, handheld remote-control camera system (courtesy of Vigilent Telesystems, Dorval, QC, Canada).

Perhaps the best example of a major telemedicine program developed with the efficient use of resources in mind is the Apollo Telemedicine Networking Foundation (ATNF), which is part of the Apollo Healthcare System in India. The ATNF president, Krishnan Ganapathy, is a neurosurgeon in Chennai who has spearheaded the development of a telemedicine system not only to support health care throughout India but also to provide teleconsulting services on a

daily basis to other countries in the region and additionally to over 20 sub-Saharan African countries [16].

1.4 DISASTER RESPONSE—LESSONS FROM TRAUMA AND STROKE CENTERS

Decades ago, it was documented that prompt medical/ surgical treatment for both trauma and stroke victims resulted in improved outcomes. Thus having hospitals and medical centers with 24/7 availability of the personnel needed to treat trauma and stroke victims (either in-house or on-call for immediate response) became the norm in developed countries. Recent reports confirm the advantage of trauma and stroke centers for patient outcomes. Regarding trauma centers, a recent study considered over 6,000 severely injured motor vehicle accident victims who were initially taken either to a trauma center or to a nontrauma center (and transferred to a trauma center with 24 h for more definitive care) [17]. Nearly half of the victims (45%) were taken directly to a trauma center, and more than half of those taken initially to a non-trauma center were transferred to a trauma center within 24 h (57% of the non-trauma center patients). Those patients who were initially triaged to a non-trauma center had a 30% increase in mortality at 48 h after injury than those who were initially triaged to a trauma center. Regarding stroke centers, a study of all patients in Finland who suffered an ischemic stroke 1999–2006 (more than 60,000 patients) considered whether the patient was treated in a general hospital or in a stroke center (primary or comprehensive) [18]. The case-fatality rate by 1 year for patients treated in a stroke center was less than 18%, while for those treated in a general hospital, it was over 27%; the percentage of patients treated in a stroke center who were home at 1 year was over 73%, while for those treated in a general hospital, it was less than 60%.

What can be learned from the trauma and stroke center systems to improve disaster response? The key to the success of the trauma/stroke center model is that it is fully integrated into the ongoing healthcare system. A trauma or stroke patient is treated in a manner identical to any other patient requiring medical care; there is no separate or parallel delivery system for trauma/stroke care. From medical student education to the rehabilitation phase of patient care, the treatment of trauma/stroke patients—and the trauma/stroke center concept—has been completely integrated into the ongoing healthcare delivery and education system. There is no separate administration or bureaucracy whose approval

must be sought before treating a trauma or stroke patient. Clearly, if there were such a separate bureaucracy or authorization process, the resulting delays in care delivery would render useless any potential advantages of having the trauma/stroke medical personnel in place.

1.5 DISASTER RESPONSE—CREATING OPPORTUNITY FROM UNPREDICTABLE, UNPREVENTABLE AND IMPERSONAL MEDICINE

There are other significant advantages to integrating disaster response into the ongoing healthcare delivery and educations system—beyond the immediate response necessary to achieve improved morbidity and mortality in disaster situations. One of the major goals of many international medical/surgical organizations—organizations often composed of the individual national or regional medical/surgical societies—is the standardization of medical/surgical education and training across nations, as well as the standardization of certification of trainees for licensure in their given specialty. Neurosurgery is a specialty intimately involved in disaster response and will be considered here with regard to benefits beyond improved patient outcomes in disasters. However, the points made below apply to other specialties ranging from emergency medicine to anesthesiology to trauma surgery to orthopaedics, etc.

The primary global neurosurgical organization is the World Federation of Neurosurgical Societies (WFNS), which consists of five continental neurosurgical associations, e.g. the European Association of Neurosurgical Societies (EANS), 114 national neurosurgical societies and five affiliate societies, in total involving 30,000 neurosurgeons worldwide. To quote from the WFNS website [19]:

> "The WFNS aspires to promote global improvement in neurosurgical care. The mission of the WFNS is to work together with our member societies to improve worldwide neurosurgical care, training and research to benefit our patients. ...The purpose of this Federation shall be the advancement of neurological surgery in all of its aspects by...promoting, implementing and improving minimum and higher standards of neurosurgical care and training worldwide."

To date, neurosurgical training and certification for practice as a neurosurgeon has taken place at the country level. An exception to this has been the

creation by the WFNS of 19 regional international training centers such as the WFNS-sponsored neurosurgical training center for young African neurosurgeons in Rabat, Morocco, that began in 2002.

The EANS has taken the lead in unifying neurosurgical education, training and certification by offering courses that provide continuing medical education throughout the European Union as well as written and oral certification examinations (similar to the US board certification process) that are also recognized throughout the European Union. Individual neurosurgical training programs anywhere in the European Union can apply to become an EANS-accredited neurosurgical training program. A global disaster response system would address one of the primary purposes of worldwide medical/surgical societies such as the WFNS—the establishment of universal high- standard medical/surgical training.

The advantages of such a global disaster response system for the goals of multinational medical/surgical organizations such as the WFNS and EANS include:

1. Global standards for medical education and training
2. Global standards for medical certification of competency and licensure
3. The exchange of in-training (residents/registrars) and senior physicians/surgeons that becomes possible with global standards
4. The camaraderie amongst physicians/surgeons worldwide that results from such personnel exchanges
5. The benefits on medical/surgical demography worldwide that result from such personnel exchanges
6. The world-class research opportunities that result from global disaster response—a platform for a global approach to understanding medical/surgical problems ranging from trauma to post-disaster infections and psychological disorders

1.6 DISASTER RESPONSE—IMPLEMENTING AND INTEGRATING THE DRC INTO ONGOING HEALTH CARE

We have seen that the trauma/stroke center model of integration into the ongoing healthcare delivery and education structure can result in improved patient outcomes in local (and national) trauma/stroke events. "Immediate" is one key word in these programs that require timely response—the equipment

and personnel must be ready on a moment's notice "24/7" to provide care. "Integration" is the other key word in the success of these programs that require timely response—not a response conditional on administrative authorizations by even one agency (let alone the multitude of agencies even in a single country) that are required for a disaster response at present. Eliminating the administrative "middleman" (actually "middlemen", "middle persons" or "middle bureaucracy" is more accurate) in trauma/ stroke centers has saved countless lives over the past several decades. The time has come to apply this model to disaster response—which requires a multinational/ regional (and ideally global) integration of the immediate response seen in trauma/stroke centers.

How can such a global disaster response program be initiated? To be effective, a disaster response center (DRC) must be located within a reasonable distance/ time from any potential disaster site. Practically speaking for helicopter transport of the portable operating room and other resources, this means within roughly 2,000 km (the range of a transport helicopter with one refuelling stop—in effect about 10 h transport time). This would allow an operating room to be functional at a disaster site within 24 h of a disaster, although with an increasing number of DRCs and improvements—with practice—in the time necessary to set up the operating room and other resources at the disaster site, the time from notification to medical/surgical support should be decreased to 12 h or less.

To be within 2,000 km of most of the world's population (in regions whose health care can be considered less than "developed"), one would need at least four DRC sites: centrally located in both (1) South America and (2) Africa, as well as (3) Central Asia and (4) Southeast Asia. Two of these regions have advocates who are willing to spearhead an effort to establish their respective DRCs:

1. In Iquique (Northern Chile), the medical center has the support of Leonidas Quintana and his involvement with the Chilean Ministry of Health. Iquique is quite well situated to provide timely disaster response for most of South America.
2. In Peshawar (Northwest Pakistan), Tariq Khan has a particular background and interest in neurotrauma (he has been active in the WFNS Neurotraumatology Committee), has had a well-equipped hospital built in Peshawar and also has involvement with the Pakistani Ministry of Health (including the development of a Trauma Registry for Pakistan). Peshawar is quite well situated to provide timely disaster response for most of Central Asia.

Some of the issues to be addressed for establishing a DRC:

1. Staffing: Ideally, the DRC medical staff (physicians, nurses) is composed of both in-country and out-of-country (likely mostly developed country) staff. Various organizations can provide volunteer physicians from all specialties to staff a DRC, for example, the International Medical Volunteers Association (IMVA), the Health Volunteers Overseas (HVO—US-based), Operation Giving Back (OGB—for surgeons, affiliated with the American College of Surgeons) and the Foundation for International Education in Neurological Surgery (FIENS—for neurosurgeons). For continuity, it may be desirable to emulate the FIENS "Twinning" program—where a university medical center in a developed country partners with a medical center in a developing country for the purpose of providing experienced healthcare personnel as mentors and colleagues over an extended period of time. Another ideal aspect would be for in-training physicians (residents/registrars) from developed countries to receive training at a DRC (for 3 to 12 months), which in a "twinning" situation could involve residents/registrars from the developing country DRC spending an equivalent period at the partner developed country medical center.
2. Licensure and certification: As noted above, within the global neurosurgical community, the EANS has taken the lead in cross-border standardization of licensure and certification in the European Union. A similar worldwide standard for licensure could be implemented for disaster response. Note that such licensure/certification would not be an unrestricted permanent (or renewable) licence to practice medicine in another country—but only a licence to practice during the period of disaster response (and the period when the physician or nurse is in another country for training purposes, e.g. as a volunteer at the DRC).
3. Equipment/devices/drugs/supplies: There are long-term benefits for the companies that support DRCs, from pharmaceutical companies to medical device and equipment manufacturers. Markets for medical equipment and drugs are approaching saturation in developed countries; the ability of a DRC to "fast forward" the development of the healthcare "market" in a developing region will not be overlooked by these companies. Because of the public relations benefits of humanitarian support of a DRC, companies will be eager to donate equipment, devices, drugs and supplies to the DRC, particularly in the initial stages. The favorable

tax consequences of such humanitarian medical donations are very persuasive as well.

4. Funding: The out-of-country healthcare personnel (physicians, nurses etc.) would be volunteers, and much of the equipment/devices/drugs/supplies initially provided on a humanitarian basis by medical companies shrewd enough to realize the huge healthcare growth potential in a developing country/region with a DRC. Support would gradually—after, say, the first 2 years—fall increasingly on the host country healthcare system, as the benefits of the DRC for the health of the population in the DRC's "catchment area" became obvious. Oversight by the involved organizations would establish the milestones for transition to a self-sustaining DRC.
5. Administrative approval or sanction: Once the various organizations agreed on the format and timeline for the implementation of the DRC concept (appropriate branches of the UN and WHO, host country and regional health ministries, international NGOs, international medical volunteer societies and physician/nursing organizations etc.), there would be significant "pressure" on local healthcare authorities to participate productively in the DRC. Although the local healthcare personnel may initially resent the intrusion represented by a DRC integrated into their medical center, the DRC represents a "win-win" for all parties involved. Soliciting local input on the particulars of the DRC in a given locale can be productive from the standpoints of both cost (more economical implementation) and politics (less local resistance to a new program). The benefits of learning efficient healthcare delivery from developing countries (versus assuming the developed countries have knowledge of all the best healthcare policies) have been catalogued by Nigel Crisp (who headed the National Health Service in the UK from 2001 to 2006) [20]. An ongoing, worldwide healthcare project such as the disaster response DRC should not represent a threat to even the most reclusive government. The devastating consequences of Cyclone Nargis in Myanmar in 2008 can be avoided everywhere in the world if disaster response is understood as a global humanitarian effort and not a potential espionage or subversive "photo-op".

1.7 CONCLUSIONS: DISASTER RESPONSE—BENEFITS OF PREDICTABLE, PREVENTABLE AND PERSONALIZED DISASTER MEDICINE

We conclude by summarizing the unique aspects and unique benefits of the disaster response center. Unique aspects:

1. Like trauma and stroke centers, the DRC is completely integrated into the ongoing healthcare system. The response to a disaster is identical to the response presently in a trauma center when an injured patient is identified or in a stroke center when a stroke patient is identified: the resources and personnel are immediately available to respond to the medical need—without any administrative approvals.
2. The DRC equipment and personnel, being completely integrated into the ongoing healthcare system, serve to augment the local healthcare resources during the non-disaster times. This can make the DRC quite cost-effective, especially given the equipment and personnel that will be forthcoming to create such a valuable healthcare resource for the entire region in the time of disaster and more locally for the other times. This parallels the trauma/stroke center model—where patients in urgent need of the specialized equipment and personnel of the trauma/stroke center are triaged there immediately, while patients with other less intensive medical problems are cared for in centers without such resources.
3. The humanitarian aspect of disaster response will make approaching governments for regional to global cooperation feasible. It will also make donations or discounts of drugs, devices, equipment and supplies from manufacturers more practical. Medical volunteer organizations will have the opportunity to staff simultaneously both ongoing health care in underserved regions as well as disaster response.
4. Telemedicine/telesurgery is an integral part of the DRC concept; the diffusion of telemedicine/ telesurgery throughout the world would advance rapidly in support of the DRC mission (during both disaster response and daily healthcare delivery).

Unique benefits:

1. The loss of life including patients with survivable injuries who die from delay of medical/surgical treatment that is routinely experienced today

during and immediately following disasters both natural and man-made would be significantly decreased.
2. Daily health care in regions around a DRC would improve dramatically from the infusion of healthcare resources that comes with the DRC.
3. The level of healthcare delivery and medical education would improve in developing countries as they partner with healthcare delivery and medical education in developed countries to staff the DRC. Medical knowledge would flow the other way also, as the healthcare personnel from the developed countries learn techniques regarding efficient and effective healthcare delivery and medical education from their local counterparts [20].
4. Medical education and training, and licensure and certification, would all tend toward a global standard given the cross-border aspects of disaster response and the DRC. International healthcare agencies such as the WHO would assist international medical societies (e.g. for neurosurgery, the WFNS) develop uniform worldwide training and certification standards, using input from member specialists in both developed and developing countries.
5. Regional and global cooperation on disaster response amongst governments that might not be able to agree on many other issues can have, over time, profound effects on breaking down barrier in related areas such as general education (e.g. regional/global standards for high school and university diplomas) and trade (e.g. multinational companies whose products extend beyond health care narrowly defined, such as Johnson & Johnson, Siemens, General Electric, Samsung).
6. The long-term positive effects of camaraderie amongst healthcare professionals from both developed and developing countries working together on a daily basis—especially the junior and in-training personnel who are likely to benefit most from experiencing different social, political and religious points of view—are difficult to overestimate.
7. The DRC will be an unparalleled global research platform to study not only trauma but also related issues ranging from infection and sanitation to rehabilitation and post-traumatic stress.

We conclude with the observation, noted at the outset, by the UN World Conference on Disaster Reduction a decade ago [5]:

> "We have the knowledge for disaster reduction, what we need is the action. The most important condition for disaster reduction is the political commitment to

remove the institutional barriers and integrate disaster risk reduction in the strategies and programmes for sustainable development..."

Unpredictable, unpreventable and impersonal disasters—anywhere in the world—can be leveraged into a predictable medical response, with preventable consequences on morbidity and mortality and personal benefits far beyond that reduction in individual morbidity and mortality. Integrating disaster response seamlessly into the healthcare training and delivery system worldwide will have socioeconomic effects far beyond the individual lives saved—institutional barriers to universal health care, education and global development will erode in the face of the humanitarian benefits for everyone. The lack of political commitment is not an option—we can no longer afford not to act.

REFERENCES

1. US Geological Survey: Earthquake facts and statistics. Available from: http://earthquake.usgs.gov/earthquakes/. Accessed November 15, 2014.
2. Wikipedia: List of natural disasters by death toll. Available from: http://en.wikipedia.org/wiki/List_of_natural_disasters_by_death_toll. Accessed November 15, 2014.
3. UNISDR + WMO: Disaster risk and resilience – thematic think piece. UN System Task Team on the Post-2015 UN Development Agenda, May, 2012. Available from: http://www.unisdr.org. Accessed September 5, 2014.
4. United Nations: Implementation of the international strategy for disaster reduction: report of the Secretary-General. United Nations General Assembly, August 14, 2013.
5. Nations U. World Conference on Disaster Risk Reduction: Proceedings of the Conference, UN/ISDR. 2005.
6. CBS News 60 Minutes 18 Jan 2010. @katiecouric: Disaster in Haiti. Available from: http://www.cbsnews.com/videos/katiecouric-disaster-in-haiti/. Accessed March 30, 2014.
7. Nordic World AS. The Icelandic Search and Rescue Teams: Haiti Response. Available from: http://www.nordicworld.tv/. Accessed March 30, 2014.
8. UNISDR organigramme. Available from: http://www.unisdr.org. Accessed September 5, 2014.
9. WHO Emergency Response Framework 2013: WHO performance standards. Available from: http://www.who.int. Accessed September 5, 2014.
10. Daisuke Y, Shoichi T, Naruo K, Kei K, Asao K. Air evacuation missions in the great east-Japan earthquake. Japan Air Self Defense Force presentation at the Aerospace Medical Association Annual Meeting: San Diego; 2014.
11. Smart T. Designed for war, honed in disaster: ADF AME in the Asia-Pacific region. Australian Defense Force Air Medical Evacuation presentation at the Aerospace Medical Association Annual Meeting: San Diego; 2014.
12. Wikipedia: 2010 Copiapó mining accident. Available from: http://en. wikipedia.org/wiki/2010_Copiap%C3%B3_mining_accident. Accessed February 4, 2014.

13. International Federation of Red Cross and Red Crescent Societies. Myanmar: Cyclone Nargis 2008 Facts and Figures. Available from: http://www.ifrc.org. Accessed March 30, 2014.
14. Government of India, India Meteorological Department. Cyclonic Storm PHAILIN over the Bay of Bengal: A Report. Available from: http://www.imd. gov.in/section/nhac/dynamic/phailin.pdf. Accessed March 30, 2014.
15. Republic of the Philippines, National Disaster Risk Reduction and Management Council. Effects of Typhoon Yolanda (Haiyan) [NDRRMC Update SitRep No. 107, 14 March 2014]. Available from: http://www.ndrrmc. gov.ph. Accessed March 30, 2014.
16. Bollineni R. Apollo Telemedicine Networking Foundation. Center for Health Market Innovations and Access Health International, 2011. Available from: http://healthmarketinnovations.org/sites/default/files/Apollo%20Case% 20Study.pdf. Accessed February 4, 2014.
17. Haas B, Stukel TA, Gomez D, Zagorski B, De Mestral C, Sharma SV, et al. The mortality benefit of direct trauma center transport in a regional trauma system: a population-based analysis. J Trauma Acute Care Surg. 2012;72:1510–5.
18. Meretoja A, Roine RO, Kaste M, Linne M, Roine S, Juntunen M, et al. Effectiveness of primary and comprehensive stroke centers – PERFECT Stroke: a nationwide observational study from Finland. Stroke. 2010;41:1102–7.
19. World Federation of Neurosurgical Societies. Available from: http://www.wfns.org. Accessed December 6, 2013.
20. Crisp N. Turning the world upside down: the search for global health in the 21st century. Boca Raton, FL, USA: CRC Press; 2010.

CHAPTER 2

Optimal Evidence in Difficult Settings: Improving Health Interventions and Decision Making in Disasters

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2.1 INTRODUCTION

Natural and man-made disasters are a global concern, with the potential to displace, kill, and injure large numbers of people, disrupt health systems, devastate food, water, and energy supplies, shatter economies, and cause massive destruction of infrastructure [1]. Recent major disasters include the Haiti earthquake (2010), the tsunami and radiation leaks in Japan (2011), Superstorm Sandy affecting North America (2012), and typhoon Haiyan in the Philippines (2013). The chronic fragile situation in countries such as Afghanistan over the last few

decades and, more recently, the conflict in Syria can be considered man-made disasters. There are many less high-profile disasters, such as landslides in Uganda, mudslides in Bolivia, and floods in Burkina Faso. Disasters pose serious threats to health, and the lack of evidence base in disaster health response has been internationally recognised, for example after the 2010 Haiti earthquake [2].

Even if it is not possible to predict the specifics of disasters, they happen regularly and can be prepared for. The level of evidence in the disaster health response should be the same as for other health settings. A needs assessment survey by Evidence Aid (Box 1) gathered information on the views and attitudes towards systematic reviews of people involved in planning for, and responding to, disasters [3]. It showed that research evidence could play a central role in improving the effectiveness of international assistance in the planning, delivery, and recovery phases of a disaster [4]. In this paper, we discuss how disaster health interventions and decision making can benefit from an evidence-based approach, similar to other healthcare settings, and outline how methodologically sound research can build a much-needed evidence base (Box 2, Box 3, Box 4).

BOX 1. OUTLINE OF THE EVIDENCE AID INITIATIVE

Evidence Aid (www.evidenceaid.org) is an initiative that tries to improve the quality of evidence and seeks to identify which, if any, systematic reviews from the thousands available in The Cochrane Database of Systematic Reviews and elsewhere are relevant to the disaster context, and which unanswered questions should be tackled in new reviews. The aim of Evidence Aid is to improve access to evidence on how to intervene and the eventual effects before, during, and after natural disasters and other humanitarian emergencies, so as to improve health-related outcomes.

BOX 2. DO ELECTRIC FANS REDUCE ADVERSE HEALTH EFFECTS DURING HEAT WAVES?

Since 2000, an estimated 150,000 people have died in heat waves across the world. The frequency and severity of heat waves are expected to increase in the future. Electric fans have been available for decades, and are widely used globally. A recent Cochrane Review sought to determine how their use affects important health outcomes during heat waves [26]. The review revealed substantial gaps in research in the international published

and unpublished literature about the use of electric fans during heat waves, and was unable to provide robust guidance to health policy makers in support of electric fans. Instead, it recommends the conduct of randomised trials and includes the design of a trial to assess the effects of electric fans on health outcomes during heat waves. This first Evidence Aid review is an example of a systematic review that highlights knowledge gaps in important disaster health areas and might provide a basis for methodologically sound research, be it randomised or observational.

BOX 3. WHAT ARE THE EFFECTS OF INTERVENTIONS TO IMPROVE THE MICROBIAL QUALITY OF DRINKING WATER FOR PREVENTING ENDEMIC DIARRHOEA?

Diarrhoea causes more than 40% of the deaths in disasters and refugee camp settings. A review identified that interventions to improve water quality at a household level are more effective than those at the source of the water [27]. This finding led to changes in policy, with the implementation of measures to safeguard the quality of water at the household level, along with the provision of safe water in emergencies. The Red Cross now includes a hygiene education component on the treatment and storage of water at the household level in the training of local volunteers in affected populations. In the decade from 2005–2015, the inclusion of this household intervention in the emergency programme is estimated to protect the health of a substantial number of people affected by disasters, perhaps as many as nine million people around the world.

BOX 4. SYSTEMATIC REVIEWS FOR MATERNAL AND CHILD NUTRITION INTERVENTIONS

The Lancet series on Maternal and Child Undernutrition in 2008 and 2013 are good examples of how the use of systematic reviews could help the humanitarian aid community to be informed about the effectiveness of health-related interventions. The Maternal and Child Undernutrition Series have included some high-quality systematic reviews to analyse whether the evidence for specific nutrition interventions exists or is

unclear. Some Cochrane reviews suggested that vitamin A supplementation reduced allcause mortality by 24% and diarrhoearelated mortality by 28% in children aged 6–59 months [28], intermittent iron supplementation to children younger than 2 years reduced the risk of anaemia by 49% and iron deficiency by 76% [29], and zinc supplementation in pregnancy resulted in a 14% reduction in preterm birth [30]. Reviews that suggested no or small effects of nutrition interventions included zinc supplementation in addition to antibiotics in children with severe and nonsevere pneumonia. Zinc supplementation did not have a significant effect on clinical recovery or duration of hospital stay [31], and the effectiveness of vitamin D supplementation in pregnancy revealed little evidence of benefits on functional pregnancy outcomes [32].

2.2 DISASTERS: DEFINITION AND CONTEXTUAL ISSUES

For this paper, we use the definition of the United Nations Office for Disaster Risk Reduction: "A [disaster is a] serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" [5]. This definition does not differentiate between natural and man-made disasters, but from the health point of view the definition implies that a disaster is any health emergency that requires a scaled-up response through external assistance to temporarily substitute or support affected health systems.

Disasters may be the result of a sudden event such as an earthquake or a protracted cause such as malnutrition caused by famine. They may be related to epidemics or armed conflict. Often, disasters are caused by a combination of many factors, both natural and man-made, and take place in challenging political environments [6]. Health effects vary depending on the type of disaster, as well as the context (e.g., geographic, cultural, economic, political) in which it occurs (see for example the PLOS Currents: Disasters series on the human impact of cyclones, floods, earthquakes, tsunamis, and volcanoes [7]). For example, the burden of disease is strikingly different after earthquakes and tsunamis. Typically, earthquakes cause large numbers of injured in comparison to the numbers of dead, whereas tsunamis either kill people or leave them almost

physically unscathed. If we compare Japan's 1995 earthquake with the tsunami in 2011, there was a distinct difference in the numbers of injured and dead: in 1995, there were 6.8 injured for every death, whereas in 2011 there were only 0.3 injured for every death [8].

Disasters in low-income countries are more likely to cause higher mortality and morbidity than those in middle– and high-income settings, due to a variety of reasons that include higher vulnerabilities of the population, and weaker health systems infrastructure with limited or no surge capacity. However, since the Balkan conflict in the 1990s and with the "Arab Spring," disasters are more frequent in middle-income countries than in the past. To care for people affected by disasters in resource-limited countries, external assistance from elsewhere in the same country is often not enough and international health assistance may be needed. This "humanitarian assistance" is often guided by voluntary spirit. Whereas domestic assistance for a disaster will usually operate under defined laws and accountabilities, no such framework exists for international assistance [9]. Furthermore, there are no acknowledged professional standards or evidence-based guidelines for international health assistance [9], although the Foreign Medical Teams Working Group under the Global Health Cluster recently released its "Classification and Minimum Standards for Foreign Medical Teams in Sudden Onset Disasters" [10]. However, adherence to these standards is voluntary just as to the Sphere standards established in 1998 [11].

2.3 EVIDENCE FOR HEALTHCARE INTERVENTIONS IN DISASTERS

Healthcare providers in disasters need readily accessible, reliable, up-to-date information on interventions that might be considered in the context of disasters. The concept of improving health through evidence-based interventions has a strong foundation in the evidence-based healthcare approach [12]. The best available evidence has been defined as the results of methodologically sound basic and patient-centred clinical research [13]. Systematic reviews of such research, including both qualitative and quantitative studies, combined with knowledge about local values, preferences, and feasibility, are needed to allow people to make well-informed decisions and choices about interventions and actions. In addition, there is a need to apply the evidence generated by patient-centred clinical research to the real world—to bridge the "know-do" gap through operational research [14].

Whereas systematic reviews are widely used for improving health in general, their role in improving health in the context of disasters is still in its infancy, but the fundamental principles of systematic reviews still apply. Systematic reviews can be used to highlight which interventions work, which do not work, which need more research, and which, no matter how well intentioned, might be harmful. In the context of systematic reviews for health interventions in disasters, it is important to remember the challenges associated with transferring evidence from one setting to another [15], and to consider the role of "realist reviews," which seek to identify the context-mechanism-outcome, or "CMO," configuration of interventions [16]. Also, the availability of contextual summaries and translations in different languages is important along with other means of sharing knowledge, perhaps including audio podcasts and videos.

2.4 OUR PROPOSAL

Currently, research on disaster health interventions is scarce, as shown recently by Blanchet et al. [17]. Effort is needed to strengthen and expand the available evidence, and although randomised controlled trials may be practically difficult to conduct in disasters, other methodologies such as cohort and interrupted time-series studies could be used to address the full scope of interventions targeted at improving health in disasters. Systematic reviews for disaster health interventions need to take this general lack of a published evidence base into account. At this stage, we foresee two crucial, albeit initial, contributions that systematic reviews can make to health decision making in disasters. First, by collating and analysing the existing research, systematic reviews improve access to the available evidence for disaster health interventions and decision making. Second, systematic reviews identify knowledge gaps by showing that answers to relevant questions are not available. These knowledge gaps can then be targeted by new studies.

We use management of limb crush injuries in earthquakes as a concrete example of how systematic reviews could inform disaster health decision making. The international health response to the 2010 Haiti earthquake resulted in many calls for an evidence-based approach to limb management after crush injury. Although initial reports are likely to have given too crude a picture of the situation, Haiti was referred to as a "nation of amputees" [18]. The 2011 Humanitarian Action Summit led to a consensus statement from the surgical working group on managing limb amputations in disasters [19]. This example

highlights two things. First, the performance of limb amputations after earthquakes has, up until now, been a largely subjective decision. Second, objective measures and tools are needed to guide decision making, such as outcome prediction models, but there is a lack of evidence regarding such tools in the earthquake context.

In this example, we argue that a first step would be a systematic review to identify existing tools to grade the severity and predict outcomes of crush-injured limbs. Such a review could be performed according to the Cochrane methods for a diagnostic test accuracy review [20]. The review team would ideally include both people involved in health response to disasters and researchers with experience of systematic reviews. The next step would be to assess the potential usefulness of these tools in disasters, potentially through a combination of validation studies and consensus meetings. A validation study of tools to grade injury severity could be designed as a prospective cohort study and integrated into existing systems for operational research in health response agencies. The proposed predictors would be collected along with relevant and feasible outcomes, such as mortality and functional status, at different time endpoints. In addition to its potential as a clinical decision-making aid, a tool to grade injury severity might also help with transparency and accountability in decisions about management, including amputation, helping surgeons to show how their management decisions were based on best available evidence.

2.5 REMAINING CHALLENGES

Strengthening the evidence base to improve health care in disasters entails work on several fronts. First, a continuous dialogue is needed with the international disaster health community about the role of evidence in disasters and how best to produce and provide it. In health care, systematic reviews of randomised trials are generally considered the highest level of evidence for investigating the effects of interventions [21], but such trials can rarely be implemented in disasters due to ethical, logistical, and practical challenges [22]. Conducting research in the aftermath of disasters may be perceived as distracting from the primary objectives of saving lives and speeding recovery; however, this perception must be weighed against the need for proven and effective interventions that save the largest number of lives with the limited resources and capacities that are generally available in disasters. As research is the best way to determine which interventions are likely to be most effective, it can be argued that not conducting

scientifically robust research following a disaster is unethical [23]. Second, existing systematic reviews need to be identified and made available in a free, easily accessible format. Third, effective knowledge transfer is needed to help the international disaster health community to identify, conduct, and use research, including systematic reviews. Fourth, better understanding is needed of how people make decisions about interventions—how they combine the best available evidence with contextual, cultural, organisational, and stakeholder issues—and the optimal ways of doing this. Fifth, funding needs to be ensured through special grants, such as the Enhancing Learning and Research for Humanitarian Assistance (ELRHA) Rapid Response Grant [24].

In conclusion, there needs to be a paradigm shift in healthcare decision making in disaster preparedness and response, moving towards a reliable and robust evidence base for all interventions being considered in disaster risk reduction, planning, response, and recovery. Evidence Aid presents an opportunity for all those involved in disaster response to collaborate in developing and enacting the best available evidence, so as to ensure that they have the best knowledge needed to decide how to respond in the worst of times.

REFERENCES

1. United Nations (2005) Hyogo Framework for Action 2005–2015: building the resilience of nations and communities to disasters. Hyogo: United Nations.
2. de Ville de Goyet C, Sarmiento JP, Grünewal F (2011) Health response to the earthquake in Haiti, January 2010. Pan American Health Organization
3. Clarke M, Kayabu B Evidence for disaster risk reduction, planning and response: design of the Evidence Aid survey. PLOS Currents Disasters 2011 Oct 14. Edition 1. doi: 10.1371/currents.RRN1270.
4. Kayabu B, Clarke M The use of systematic reviews and other research evidence in disasters and related areas: preliminary report of a needs assessment survey. PLOS Currents Disasters 2013 Jan 22. Edition 1. doi: 10.1371/currents.dis.ed42382881b3bf79478ad503be4693ea.
5. United Nations Office for Disaster Risk Reduction (2007) Terminology. Geneva: United Nations Office for Disaster Risk Reduction.
6. Sharp D (2004) Hearts and minds, from Darfur to locusts. Lancet 364: 1741–1742.
7. Barbour V (2013 April 19) Earthquakes, cyclones, tsunamis, floods and volcanoes – assessing the human impact of each. Speaking of Medicine. PLOS Blogs Available: http://blogs.plos.org/speakingofmedicine/2013/04/19/earthquakes-cyclones-tsunamis-floods-and-volcanoes-assessing-the-human-impact-of-each/. Accessed 23 March 2014.
8. Ishigaki A, Higashi H, Sakamoto T, Shibahara S (2013) The Great East-Japan Earthquake and devastating tsunami: an update and lessons from the past great earthquakes in Japan since 1923. Tohoku J Exp Med 229: 287–299.

9. Fisher D (2010) Regulating the helping hand: improving legal preparedness for cross-border disaster medicine. Prehosp Disaster Med 25: 208–212.
10. Norton I, von Schreeb J, Aitken P, Herard P, Lajolo C (2013) Classification and minimum standards for foreign medical teams in sudden onset disasters. Geneva: World Health Organization.
11. The Sphere Project (2013) Humanitarian charter and minimum standards in humanitarian response. Rugby: The Sphere Project.
12. Evidence-based medicine. A new approach to teaching the practice of medicine. JAMA 268: 2420–2425.

View Article PubMed/NCBI Google Scholar

13. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS (1996) Evidence based medicine: what it is and what it isn't. BMJ 312: 71–72.
14. Zachariah R, Ford N, Maher D, Bissell K, Van den Bergh R, et al. (2012) Is operational research delivering the goods? The journey to success in low-income countries. Lancet Infect Dis 12: 415–421.
15. Ehrhardt S, Meyer CG (2011) Transfer of evidence-based medical guidelines to low- and middle-income countries. Trop Med Int Health 17: 144–146.
16. Pawson R, Tilley N (1997) Realistic evaluation. London: SAGE.
17. Blanchet K, Sistenich V, Ramesh A, Frison S, Warren E, et al. (2013) An evidence review of research on health interventions in humanitarian crises: final report. Enhancing Learning and Research for Humanitarian Assistance
18. Padgett T (2010 February 17) Haiti: what to do with a nation of amputees. Time
19. Knowlton LM, Gosney JE, Chackungal S, Altschuler E, Black L, et al. (2011) Consensus statements regarding the multidisciplinary care of limb amputation patients in disasters or humanitarian emergencies: report of the 2011 Humanitarian Action Summit Surgical Working Group on amputations following disasters or conflict. Prehosp Disaster Med 26: 438–448.
20. Leeflang MM, Deeks JJ, Takwoingi Y, Macaskill P (2013) Cochrane diagnostic test accuracy reviews. Syst Rev 2: 82.
21. Balshem H, Helfand M, Schunemann HJ, Oxman AD, Kunz R, et al. (2011) GRADE guidelines: 3. Rating the quality of evidence. J Clin Epidemiol 64: 401–406.
22. O'Mathuna D, Draper H, Tonnisson K (2012) Disaster bioethics: addressing ethical issues triggered by disasters. European Cooperation in Science and Technology
23. Kilpatrick DG (2004) The ethics of disaster research: a special section. J Trauma Stress 17: 361–362.
24. Enhancing Learning and Research for Humanitarian Assistance (2014) Research for Health in Humanitarian Crises (R2HC). Enhancing Learning and Research for Humanitarian Assistance
25. Vandekerckhove P, Clarke MJ, De Buck E, Allen C, Kayabu B (2013) Second evidence aid conference: prioritizing evidence in disaster aid. Disaster Med Public Health Prep 7: 593–596.
26. Gupta S, Carmichael C, Simpson C, Clarke MJ, Allen C, et al. (2012) Electric fans for reducing adverse health impacts in heatwaves. Cochrane Database Syst Rev 7: CD009888.
27. Clasen T, Schmidt WP, Rabie T, Roberts I, Cairncross S (2007) Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. BMJ 334: 782–785.

28. Imdad A, Herzer K, Mayo-Wilson E, Yakoob MY, Bhutta ZA (2010) Vitamin A supplementation for preventing morbidity and mortality in children from 6 months to 5 years of age. Cochrane Database Syst Rev CD008524.
29. De-Regil LM, Jefferds ME, Sylvetsky AC, Dowswell T (2011) Intermittent iron supplementation for improving nutrition and development in children under 12 years of age. Cochrane Database Syst Rev CD009085.
30. Mori R, Ota E, Middleton P, Tobe-Gai R, Mahomed K, et al. (2012) Zinc supplementation for improving pregnancy and infant outcome. Cochrane Database Syst Rev 7: CD000230.
31. Haider BA, Lassi ZS, Ahmed A, Bhutta ZA (2011) Zinc supplementation as an adjunct to antibiotics in the treatment of pneumonia in children 2 to 59 months of age. Cochrane Database Syst Rev CD007368.
32. De-Regil LM, Palacios C, Ansary A, Kulier R, Pena-Rosas JP (2012) Vitamin D supplementation for women during pregnancy. Cochrane Database Syst Rev 2: CD008873.

PART II
Health-Care Disaster Preparedness and Resilience

CHAPTER 3

Disaster Resilience in Tertiary Hospitals: A Cross-Sectional Survey in Shandong Province, China

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3.1 BACKGROUND

Since the outbreak of severe acute respiratory syndrome (SARS) in 2003 and the Wenchuan earthquake in 2008, substantial resources have been devoted to improving disaster resilience in China, with a particular emphasis on mitigating the impact of wide-spread infectious diseases and mass casualty incidents [1, 2]. Adequate progress can only be achieved by integrating local, provincial, and national systems [3]. Health systems are essential to enhance disaster resilience, and therefore planning at all levels should include health care facilities, such as tertiary hospitals, primary health care facilities, public health departments, and emergency medical services [4]. Within regional health systems, tertiary hospitals are the key component, as they are the main providers of health care during disasters. They also provide leadership during response phase of a disaster, and represent a critical linkage for disaster management for the whole system.

During disasters, hospitals need to withstand the event, whilst being able to maintain and surge their medical capacity, in order to respond to sudden and

significant increases in health demand [5–7]. Resilience is an emerging concept that has recently been added to the disaster management context, which describes this ability [8–10]. The resilience of hospitals can be defined as their ability to resist, absorb, and respond to the shock of disasters while maintaining critical functionality, and then to recover to their original state or adapt to a new one [8–12].

China is afflicted by many kinds of disasters, including natural disasters, manmade disasters and pandemics. Its population size amplifies the impact of these disasters on health and wellbeing. To date, few studies have evaluated the level of hospital disaster preparedness and management arrangement in China [13–16]. Moreover, standardised or consistent methods for describing and measuring hospital resilience or relevant comprehensive ability are lacking [17]. Understanding the status of hospital disaster resilience is the first step in planning to enhance effective emergency response of hospitals. This article aims to explore the current status of disaster resilience in tertiary hospitals in Shandong Province. It has four objectives: (1) to identify the current status of tertiary hospitals' ability to cope with disasters in the Province; (2) offer references for similar studies; (3) to test the construct validity and the utility of an emerging framework as a basis for understanding and measuring hospital disaster resilience; and (4) to identify any variability in hospital disaster resilience in Shandong Province using this framework, in order to inform a more cohesive approach to health authorities and hospital managers.

3.2 METHODS

The survey questionnaire used in this study was developed from an established framework of hospital disaster resilience. The framework was derived from analysis of existing literature and through a three-round of Modified-Delphi consultation with key experts in China [18]. The resultant questionnaire consists of 9 sections and 166 items (the framework and questionnaire can be found in Appendix 3.1 and 3.2). Most questions are in the format of binary variables, and can be answered by "yes" or "no". The relevant framework and questionnaire are found in the Appendices.

The feasibility and suitability of the questionnaire were tested by a pilot study of three hospitals (n = 3). For the purpose of this study, we collected and analyzed the data focused on the following areas of interest: (1) hospital demographic data; (2) hospital internal safety (e.g., infrastructural safety and

strategies for infectious diseases); (3) emergency leadership and cooperation; (4) disaster plan; (5) disaster stockpile and logistics management; (6) emergency staff; (7) emergency critical care capability (e.g., on-site rescue, hospital treatment, surge capacity); (8) training and drills; (9) and disaster recovery mechanism. Excluding the first section of the survey which addressed demographic information, Sections 2–9 (covering 161 survey questions) represent the eight key domains of the established evaluation framework of hospital disaster resilience.

A tertiary hospital is defined as cross-regional facility providing comprehensive and specialized medical care. In China they are further classified into subgroups: Grade A, Grade B, and Grade C according to their service levels, size, medical technology, medical equipment, management and medical quality [19]. Shandong province is the second largest province and is located in the east of China. In this study, a cross-sectional survey was conducted in tertiary hospitals of Shandong province in China. A total of 50 tertiary hospitals in Shandong Province were selected using stratified random sampling according to their subgroups (i.e., Grade A, B, C). The sample was composed of 28 tertiary A hospitals, 20 tertiary B hospitals and 2 tertiary C hospitals, which was selected using the contact list obtained from the Provincial health department. Between January 2013 and June 2013, the questionnaire accompanied by an official letter from the provincial health department stating the importance of the survey was sent to these hospitals. Each hospital was asked to designate a department director to be responsible for coordinating the completion of the questionnaire. Ethical approval was obtained from Queensland University of Technology (approval number 1200000170) and written informed consent obtained from each participant hospital.

Each returned questionnaire was reviewed for its completeness and consistency. For those questionnaires which were incomplete and/or contained inconsistent responses follow-up telephone calls were made to ensure completeness and consistency. The data from returned questionnaires were then transferred into a database, which was set up using Microsoft office access 2007. Data was checked, cleaned, and analysed using SPSS Statistics version 21. As the study was conducted in China, the Chinese language was used to capture responses, but the results subsequently were translated into English for final analysis and reporting.

A score was assigned for the binary variables (e.g., "is there"). Two options of "yes" or "no" are assigned to the score of "1"or "0" respectively. Then, the scores of each domain were calculated by adding together the score of all the relevant

questions. A total score was calculated by summing the score across all eight domains, which is a proxy for measuring disaster resilience in an institution. The higher the total score, the better the hospital's disaster resilience.

Further analyses were conducted to understand the correlation between resilience domains and the descriptive information about the hospitals. A mean score and ninety-five percent confidence interval of means (95% CI) were used to describe each resilience domain. Comparisons of the mean score of each resilience domain among different hospital categorizes were performed, with $p < 0.05$ as the level of statistical significance. Due to the small sample, non-parameter test (Mann–Whitney Test) was used as the statistical method. Factor Analysis was used to test the construct validity of the evaluation framework by extracting key factors of disaster resilience from the different domains. Most variables in this study were analysed using descriptive statistics such as frequencies and percentage.

3.3 RESULTS

A response rate of 82% (n = 41) was attained. After analysis of the data from these 41 hospitals, it was found that the eight domains of disaster resilience have good overall internal statistical consistency (Cronbach alpha = 0.780). A comparison of these domains among different categories of hospitals is shown in Table 3.1. The mean score of each domain of tertiary grade A hospitals was higher than that of tertiary grade B separately, and statistical difference was confirmed among most domains. The mean score of general hospitals was higher than that of specialized hospitals in most domains. However, only the statistical difference among two domains was tested. The mean score of hospitals that were assigned the mission of regional disaster rescue was higher than those hospitals without this mission. Statistical difference among most domains was tested. In addition, most of the hospitals (92.3%) that has been assigned missions were tertiary A hospitals in the sample.

Factor Analysis (using Initial Component Matrix, and Rotated Component Matrix by Varimax with Kaiser Normalization) was chosen to extract key factors of disaster resilience from the eight different domains [20]. After analysis, a four factor solution was identified that can be used to represent all the domains. The score of each factor was obtained by regression analysis applied to the sample. According to Table 3.2, each factor score of the hospital sample can be expressed using the following modelling:

TABLE 1 Comparison of eight domains of hospital resilience, categorized by different characteristics of hospitals, Shandong, China, 2012

Var.		No.	Domains							
			Leadership	Plan	Stockpile	Safety	Critical care	Staff	Training	Recovery
			Mean 95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI
Level	Tertiary A	27	5.78	6.22	2.26	8.07	9.34	10.59	8.98	0.89
			5.35,6.21 *	5.81,6.64 *	1.98,2.54 *	7.44,8.70 *	7.53,11.16	8.16,13.02	7.62,10.33 *	0.501.27 *
	Tertiary B	14	4.43	3.36	1.29	6.93	8.71	10.29	5.32	0.07
			3.89,4.97 *	2.49,4.22 *	0.63,1.94 *	6.31,7.55 *	5.74,11.69	6.26,14.31	3.56,7.08 *	−0.08,0.23 *
Type	General	27	5.52	5.11	2.00	7.63	10.49	12.77	8.27	0.67
			5.05,5.99	4.33,5.90	1.59,2.41 *	7.09,8.17	8.59,12.39 *	10.25,15.30 *	6.65,9.89 *	0.27,1.06
	Specialized	14	4.93	5.50	1.79	7.79	6.50	6.07	6.68	0.50
			4.23,5.63	4.63,6.37	1.27,2.30 *	6.72,8.85	4.55,8.45 *	4.18,7.96 *	5.17,8.20 *	0.12,0.88
Disaster Mission	Assigned	13	6.23	6.46	2.38	8.23	11.77	14.23	11.06	1.23
			5.57,6.89 *	5.62,7.30 *	2.08,2.69	7.48,8.98	9.29,14.25 *	10.58,17.88 *	9.43,12.69 *	0.67,1.79 *
	No mission	28	4.89	4.68	1.71	7.43	7.90	8.74	6.18	0.32
			4.49,5.29 *	4.00,5.35 *	1.29,2.13	6.81,8.05	6.14,9.67 *	6.49,10.99 *	5.00,7.36 *	0.04,0.60 *
Total		41	5.32	5.24	1.93	7.68	9.13	10.48	7.73	0.61

Emergency leadership and cooperation, (highest score = 7); disaster plan, (highest score = 7); disaster stockpile and logistics management, (highest score = 4); hospital safety, (highest score = 9); emergency critical care capability, (highest score = 19); emergency staff, (highest score = 17); trainings and drills (highest score = 15); recovery mechanism (highest score =3).

*P < 0.05; Tested by non-parameter test (Mann–Whitney Test).

MS, Mean score.

95% CI: 95% confidence interval of means.

$$F_1 = 0.524X_1+0.570X_2 +0.191X_3-0.080X_4-0.220X_5-0.083X_6-0.147X_7 +0.080X_8$$

$$F_2 = 0.030X_1-0.315X_2+0.138X_3+0.443X_4 +0.182X_5+0.659X_6-0.214X_7-0.211X_8$$

$$F_3 = -0.253X_1-0.116X_2+0.093X_3+0.007X_4 +0.364X_5-0.318X_6+0.936X_7-0.199X_8$$

$$F_4 = -0.144X_1+0.288X_2-0.109X_3-0.119X_4 +0.148X_5-0.167X_6-0.148X_7+0.972X_8.$$

TABLE 3.2 Component score coefficient matrix

Domains	Component factors			
	F1	F2	F3	F4
1. Emergency critical care (X_1)	.524	.030	–.253	–.144
2. Emergency staff (X_2)	.570	–.315	–.116	.288
3. Emergency training and drills (X_3)	.191	.138	.093	–.109
4. Crisis leadership and cooperation (X_4)	–.080	.443	.007	–.119
5. Disaster plans (X_5)	–.220	.182	.364	.148
6. Recovery (X_6)	–.083	.659	–.318	–.167
7. Disaster stockpiles and logistics (X_7)	–.147	–.214	.936	–.148
8. Hospital internal safety (X_8)	.080	–.211	–.199	.972

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

The four factors were identified and named as: hospital disaster medical care capability (F1), hospital disaster management mechanism (F2), hospital disaster resources (F3) and hospital safety (F4). These four factors account comprehensively for the overall level of disaster resilience capability. The weight of each factor was assigned using the total variance from factor analysis (the weight of each factor is assigned by the proportion of the variance contribution of each principal to the cumulative variance contribution of the four primary factors) [20]. Then the evaluation model of hospital disaster resilience can be established, and the overall level of hospital disaster resilience (F) can be calculated using the model as below:

$$F = 0.615F_1+0.202F_2+0.103F_3+0.080F_4.$$

The overall score of disaster resilience (F) for each hospital of this study can be calculated accordingly with their relative rank are listed as Table 3.3. Due to ethical issues, the hospital name is replaced with hospital ID in this study. According to Table 3.2, there are 20 hospitals whose average of comprehensive scores (F) were positive, which account for about 50% of all of the sample quantity. It illustrated that the hospital disaster resilience in the province was still insufficient with a big difference among those sampled. Similarly, the score of each four factors (F1, F2, F3, and F4) can be calculated and ranked respectively according to Table 3.2, and thus to identify the score of factors which tend to be relatively lower in an area and should probably be the highest priority for strengthening resilience. As a result, it was found that in the study sample, the score of hospital disaster management mechanism (F2) was relatively lower than the other three factors with less than 50% of hospitals having positive scores. Below we describe in detail of the status of each of these four factors in tertiary hospitals of the study province.

TABLE 3.3 Overall score of hospital disaster resilience (F) and its rank in the hospital sample

ID	F	Rank	ID	F	Rank	ID	F	Rank	ID	F	Rank
1	−0.554	32	11	−0.33	31	21	0.7885	5	31	−0.235	28
2	−0.997	37	12	0.482	11	22	0.3393	15	32	0.412	12
3	0.384	13	13	−0.195	26	23	1.120	1	33	0.0990	18
4	−0.206	27	14	−0.970	36	24	−0.093	23	34	0.733	7
5	−0.750	35	15	−1.189	41	25	0.095	19	35	0.331	16
6	−0.147	24	16	−1.126	40	26	−0.262	30	36	0.733	8
7	0.049	20	17	−1.005	38	27	−0.085	22	37	1.088	2
8	−0.239	29	18	−1.116	39	28	0.774	6	38	0.932	3
9	0.262	17	19	−0.04	21	29	0.623	9	39	−0.176	25
10	0.550	10	20	0.8624	4	30	−0.572	33	40	0.360	14
									41	−0.729	34

3.3.1 Hospital Safety (Factor 1)

Most of the responding hospitals (92.7%) had developed syndromic surveillance systems for certain high risk of infectious diseases (e.g., SARS, Human H5N1 Avian Flu, and Human H9N11 Avian Flu) and required that physicians on duty

report any suspicious cases to the hospitals' presidents. 92.7% of responders had established a direct online reporting system to report suspicious cases and shared data with the local health authority. Most of responders (85.4%) could analysis surveillance data regularly.

Only 12.2% of all the responding hospitals had local risk evaluation for hospital prevention and mitigation, and all of them are tertiary A hospitals. More than half (68.3%) had evaluated critical infrastructure vulnerability and safety standards. Yet, this percentage varied with 88.9% within tertiary A hospitals but only 28.6% within tertiary B hospitals. All the hospitals had considered construction safety standards for the risk of fire, and most (92.7%) had considered using isolated pathways and designated areas for infectious diseases. Comparatively, a relatively lower percentage had considered building to a higher standard or level of resistance than the local criteria for earthquake disasters (82.9%), and floods (73.2%). Almost all of them (97.6%) had strategies to evacuate and protect existing patients when the hospital is at risk, but only 61.0% reported to have alternative emergency energy and facilities for backup (including power, water, oxygen and telecommunication). The percentage having alternative backup was found different among tertiary A and tertiary B hospitals, with 74.1% and 35.7% respectively.

3.3.2 Hospital Disaster Management Mechanism (Factor 2)

All of the surveyed hospitals (100%) had a general plan for public emergencies. While only a small percentage (19.5%) had specific plans based on the specific requirements of a single hazard, this was 75% in tertiary A hospitals. The most common hazards identified in the specific plans are infectious diseases (92.7%), internal medical accidents (90.2%), and public health emergencies, such as occupational or food poisoning (73.2%). Only a small percentage had established specific plans of dealing with natural disasters, such as fire (68.3%), earthquakes (48.8%), floods (36.6%), and even less for bio-terrorism and nuclear terrorism (31.7%). Regarding standard operating procedures, over four-fifths of the responding hospitals (85.4%) possessed a protocol to initiate the plan, so as to guarantee the availability of staff, equipment and resources, while less than three-quarters (73.2%) had a classification response system for different levels and different phases of events. Most hospitals (87.8%) reported that they could operate in accordance with the plan during disasters. Approximately half of them (51.2%) had evaluated and revised their emergency plan at least once

in the last two years, and a similar percentage (53.7%) reported the content of plans was disseminated by key staff through regular meetings or training.

Regarding the incident command system, all reported to have a command center and most (97.6%) had designated a specific department to be responsible for the relevant work. As for communication, 87.8% had coordinating meeting during emergencies with key staff from different hospital departments, and less (48.8%) had a public and mass media communication protocol, and less still (43.9%) had attended the local coordinating meeting with other emergency departments, such as CDC (Center for Disease Prevention and Control), pre-hospital emergency system, healthcare facilities, blood and resource center, and local government. It was noteworthy that general hospitals did not appear to be obviously superior to specialized hospitals in disaster planning or cooperation with other facilities. However, the hospitals with assigned rescue missions had better cooperation mechanisms, among them with 61.5% attended the local coordinating meeting, while a smaller percentage (42.9%) in other hospitals.

Less than half (48.8%) had after-event evaluation report to capture lessons to be learned, and to assist to evaluate hospital vulnerability, and adapt strategies for improving future performance. However, a larger percentage (59.3%) of tertiary A hospitals had this evaluation report compared with tertiary B hospitals (28.6%). Only 26.8% had specific channels of investing money, transferring staff, and purchasing equipment for recovery. Approximately one-fifth (19.5%) of hospitals indicated that they were involved or would be involved in the health related work of affected communities (e.g.., rehabilitation and psychological consultation, health evaluation and health intervention of the community).

3.3.3. Hospital Disaster Resources (Factor 3)

Our results revealed that 75.6% of the participating hospitals had stockpiles of emergency drugs, and 43.9% had signed contracts with emergency drug-supplies to provide drugs during emergencies, only 22.0% had signed Memorandum of Understandings (MOUs) with other hospitals to share emergency drugs during emergencies. 48.8% had drug-distribution plans to identify distribution priority of drugs during crisis, and 41.5% could be able to load and deliver emergency drugs for on-site rescue. With regards to other medical materials, 87.5% had stockpiles of emergency materials (e.g., food, water, stretcher, and tourniquet). But only 29.3% could share and obtain these materials from other hospitals during emergencies. It was noteworthy that a greater percentage of tertiary

A hospitals had a signed Memorandum of Understandings (MOUs) to share emergency materials than tertiary B hospitals (42.9% among tertiary A and 22.2% among tertiary B hospitals). To protect staff, some of the hospitals had biohazard protective suits (58.5%), goggles (63.4%), ventilator (73.2%), and N95 Masks (41.5%). Only 24.4% had purchased all the mentioned personal protective equipment (PPE). There was also a greater percentage of tertiary A hospitals had access to all PPE than tertiary B hospitals (33.3% among tertiary A and 7.1% among tertiary B).

3.3.4 Hospital Disaster Medical Care Capability (Factor 4)

The most important function of hospitals during emergencies is maintaining and surging services to ensure medical care for victims of disasters, either on-site or within hospitals. For onsite-rescue, most (92.7%) had their own ambulances, among them 73.7% had ward-type ambulances, but only 15.8% had access to a negative pressure isolation ambulance. Only two of them had their own rescue helicopters and access to a helicopter landing pad. More than half (65.8%) could dispatch emergency staff during disasters for the on-site rescue. About one third (31.7%) could organise an independent rescue team that is equipped with emergency package of supplies for living 3 days (including daily necessities, a set of emergency package, and first aid kit, et al.). Not surprisingly, among them most (92.3%) were tertiary A hospitals. Less than a quarter of the hospitals (22.0%) were equipped with portable medical equipment (e.g., portable breathing machine, ECG monitoring machine, and the X-ray machine), and all of these hospitals were tertiary A. The rescue teams comprised physicians, nurses and administrative staff from various departments (e.g., surgery department, medicine department, psychology department, infection control department and management department), and the dispatched staff number had a wide range from 13 persons to 103 persons. Over a third (36.6%) of the responding hospitals had an on-site command vehicle and a similar proportion (39.0%) had on-site communication equipment for data transmission, video-audio connection, and remote consultation. However, only 4.88% hospitals had a 'portable hospital' or the capability to support field surgery, and other critical care in the field, which is similar to the function of ICU (using vehicles which are equipped with beds, and portable medical equipment).

For hospital treatment, 90.2% had emergency beds, 80.5% had isolation beds, and 65.9% had Intensive Care beds. In terms of capacity to treat patients

with different medical needs or case-mix 73.2% had orthopaedic beds, 56.1% had special beds for burns (e.g., suspension bed, emancipated beds) and 59.5% had hyperbaric oxygen chamber. While 73.2% had achieved capacity (e.g., space, beds and experts) for treating mass casualty of trauma, 73.2% for infectious diseases, 48.8% for mass casualty of blast injury, gunshot wounds and crush injury, 46.3% for acute chemical poisoning, only 17.1% could treat radiation issues. In this study mass casualty capacity refers to each hospital is to assess itself on its capacity to accept at least 30 patients of the same disease within a short period [21]. Most of the responding hospitals had medical care equipment, such as breathing machine (100%), vital signs monitors (100%), defibrillator machines (90.2%), and cardiac resuscitation devices (70.7%).

For surge capacity, 65.9% had prepared conditions (e.g., electricity, oxygen, water and space) to surge patient-care beds, while 53.7% had concrete surging plans, and among them 66.7% within tertiary A but only 28.6% within tertiary B hospitals. Only 36.6% adopted a wide variety of flexible procedures for surging their beds capacity, through early discharge of patients (85.4%), cancellation of elective admissions (63.4%), and transfer patients to primary health care and other facilities (61.0%). However, these hospitals can only surge 12.52% of their total beds within an average of 24 hours (3.76% used extra space, 8.76% could empty beds). Notably, of the14 tertiary B hospitals the surge capacity was even less, as claimed they could only surge 2.48% of their total beds within 24 hours. More than half (61.0%) had mass-casualty triage procedures for admission of patients who require urgent medical care during disasters, and 92% were tertiary A hospitals. Only a few (12.2%) could surge staff using a wide variety of flexible strategies, including recalling all the off work staff back to work (100%), rehiring retired staff (73.2%), suppling living places for staff (61.0%), training and transferring non-critical care staff to support critical care (41.5%), sharing staff from other hospitals (31.7%), and using volunteers or temporary employers (19.5%).

Disaster trainings and drills can be used regularly to improve hospital medical response efficiency. Most of the responding hospitals (95.1%) had disaster training programs and 53.7% had drills, to treat the following emergency types respectively, including: infectious disease (73.2%, 73.2%); mass casualty incidents (53.7%, 48.8%), career poising and food poising (48.8%, 36.6%), and bio-terrorism and nuclear terrorism (14.6%, 7.3%). About 85.4% had training curriculums, and 90.2% updated them regularly. The content of training included cardiopulmonary resuscitation (97.3%), trachea cannulation (89.2%), basic skills for the treatment of trauma (63.6%), transfer of casualties (56.4%), disaster management (12.2%) and triage (12.2%). Approximately one-fifth

(19.5%) had attended community drills cooperating with the other emergency facilities. Among them, 25.9% within tertiary A hospitals and only 7.1% within tertiary B hospitals. All the hospitals that conducted such interagency drills were those that had been assigned rescue missions, and they accounted for 61.5% of the mission assigned hospitals.

3.4 DISCUSSION

This study has examined the utility of a comprehensive evaluation framework and its derived questionnaire for furthering the understanding and measurement of the component parts of effective hospital resilience. There are 8 key domains of hospital resilience, and as a result four key factors were extracted from them. Among these factors, emergency medical care is the most important capability, while others (hospital safety, management mechanism, and disaster resources) are supporting capability to guarantee its continuity and surging. This framework of hospital resilience provides a starting point for integrating these key components of hospital resilience together into a comprehensive disaster management framework (including prevention, preparedness, responsiveness, and recovery and adaptation phases). It also seeks to make an achievable goal of improving hospital pre-disaster strength (robustness) and promoting rapidity of response and recovery. This goal can be achieved through a wide range of management approaches including redundancy of processes and resources, and resourcefulness (or flexibility) of plans or strategies (i.e.: can be reflected by some key variables in the survey) [22–26].

Considerable variability in the scope of disaster resilience arrangement of hospitals in the Province was identified through a survey conducted using the self-report questionnaire. We have stratified our analyses by different level of hospitals. It was noticed that in some key areas (e.g., safety evaluation, planning and cooperation, MOUs, personal protective equipment, rescue, surge capacity and drills), there was a difference in disaster resilience arrangements between tertiary A and tertiary B hospitals. This may be due to different levels or types of hospitals having divergent functions in disasters. For example, most (92.3%) of the hospitals that have been assigned missions were tertiary A, and thus they should be more resilient to disasters for health service supply, and should have better arrangements in the above areas for disaster preparedness and response.

This paper offered a four-factor structure as a way of modelling the overall level of hospital resilience and the level of each factor independently. Thus

the questionnaire can be used to provide a helpful and comprehensive instrument for assisting hospitals to assess their level of resilience at a regional or a district level in regard to disasters, and assist them in identifying areas for further strengthening their resilience capability through comparison with similar components of other hospitals. The evaluation framework and its key measures in the questionnaire may inform the development of hospital resilience evaluation in other countries.

Similar indicators in this study can be compared with other studies, especially on hospital disaster preparedness and management [13, 16]. One survey has been conducted in 2005 to evaluate secondary and tertiary hospitals of Shandong [13]. Comparing its results, it was found that the percentage of most similar indicators in our study is reasonable higher, such as the percentages of: syndromic surveillance systems, single-hazard disaster plans, public and mass media communication protocol, stockpiles of emergency resources, and training programs and drills. Thus, to some extent, it was validated the representativeness of the sample in this study to reflect the status of the province. Additionally, it was found that hospital disaster preparedness in Shandong province is close to Beijing (the capital city), and it is above the average level of preparedness in China, due to economic factors and other factors [13]. It is expected that hospital disaster ability in many other parts of China may lag well behind that of Shandong province. Thus, understanding the status of hospital disaster resilience in this province can be used as the first step in planning effective hospital resilience.

After the SARS crisis, the preparedness of hospitals in China especially for infectious diseases has improved significantly [14]. Our survey revealed that these tertiary hospitals had devised disaster plans and command structures. Almost all of the surveyed hospitals possessed strategies to evacuate and protect existing patients when there is risk in hospitals. Most of them had syndromic surveillance systems. Many had different personal protective equipment and had relevant training programs. A large percentage of them had stockpiles of emergency drugs and resources and had the ability to accept more than 30 cases of infectious diseases within a short period.

These results also highlighted the following shortfall areas in current hospital disaster resilience in Shandong. Firstly, for disaster management mechanism, in US, nearly 67.9% had specific plans for all the essential individual hazards in 2008 [27]. Comparatively, disaster plans in this Province of China had less considerable scope for improving their preparedness for natural disasters, biological, nuclear radiation and other terrorist attacks.

Secondly, for disaster resources, simply stockpiling materials fails to achieve adequate hospital surge capacity, especially in the aftermath of a catastrophic disaster. The community should have functional inter-hospital arrangements to share personnel and resources [4]. In the US, nearly 87.8% of hospitals had MOUs with other hospitals to transfer general patients, 84.1% had contract with other agencies to share suppliers, and more than 70% of hospitals performed mass casualty drills with outside organizations [27]. However, in the Province of China, less than half of the responding hospitals had signed contracts with drug-supplies, and less than one third had signed MOUs with other hospitals to share resources and staff. Also less than half had attended the local coordinating meeting, and only one fifth had attended community-wide drills. The lack of cross-institutional interaction and coordination would likely hinder the availability of resources in a community, and limit timely disaster response.

Finally, continuity of medical care is amongst the most important objectives for prompt and effective response to emergencies. As the experience from developed courtiers, on-site rescue can be enhanced either through dispatched rescue teams (be equipped with living supplies for 3 to 5 days and portable medical equipment) and advanced 'portable hospitals' (be equipped with various functional vehicles that can be used for operating surgery, accepting patients, on-site command and communication and etc.) [28]. However, there is still insufficiency of on-site medical rescue, especially a lack of "portability" of critical care service (i.e., patient transport and bringing care to the patient). These two models of on-site rescue still need to be further developed, as they are scalable, mobile and can surge medical care service significantly even after catastrophic disasters [28]. Additionally, medical care capability requires significant surge capacity during disasters, with a critical feature of hospital staffed beds [4]. In US, most hospitals had plans and flexible procedures for surging staffed beds [27]. Also it has been surveyed that in the hospitals of Kentucky, the surge capacity equal to 27% of licensed beds [29]. However, in this study, only less than one fourth of responding hospitals had a wide variety of flexible procedures for surging their beds and emergency staff. The surge capacity within 24 hours is 12.52% of fixed beds, which is relatively low.

Cohesive approaches have been identified using the evaluation framework and its key variables. They can be used by hospital managers and health authorities to enhance general practices to achieve effective disaster resilient. It also can used to assess hospitals, so as to identify the vulnerabilities and improve disaster capability further. These approaches include:

- Hospital safety: (1) Evaluation of locally prioritized hazards, and enforcement of safety standards that need to meet or exceed the local standards; [30, 31] (2) Evacuation plan in place and have special procedures to protect and evacuate vulnerable people when there is risk within the hospital.
- Disaster mechanism: (3) The existence of disaster plans that have been developed in advance of a disaster, taking into consideration the communities' resources, hazards and other unique factors; [2, 13] (4) The establishment of a specific department to take responsibility of incident command and control, crisis communication and cooperation, and after-event recovery; [13] (5) Incorporation of the hospital into the overall local disaster planning, including inter-facility cooperation and alternative plans to transfer patients to other hospitals if the hospital is partly destroyed or become unusable [28];
- Disaster resources: (6) Stockpile of self-sufficient resources and emergency drugs for at least 48 to 72 hours, so as to cope with major disasters initially; [32] (7) Establishment of MOUs with other hospitals for transferring patient and the sharing of staffing, equipment, and supplies; [4] A community-wide, integrated, inter-agency network should be built, with local hospitals working together to surge overall capacity collectively [33].
- Emergency medical care: (8) Transportation of the medical staff or transferring patients to hospitals in a timely manner, and the provision of medical care service on site, which can be in the form of rescue teams or 'portable hospital' especially during catastrophic disasters; [28] (9) Disaster surge planning should be devised in advance by adoption of a wide variety of flexible strategies (e.g., disaster triage, ability to surge beds and staff, ability to transfer patients, early discharge of patients) for surging medical demands from wide-spread infectious diseases or mass casualty incidents; [27, 33, 34] (10) Development of hospital internal conditions (e.g., space, beds, treatment protocols and on-call specialists) for treating patients according to type and magnitude of event(s); [13] (11) Systematic and ongoing training and drill staff for emergency medical care skills, equipment usage and disaster management skills in high risk communities [35].

The current study has several limitations. Firstly, the likelihood of non-response bias was likely to exist. As a relatively larger percentage of tertiary A hospitals replied to the survey than the tertiary B and tertiary C hospitals. Although two reminders were sent to the hospital coordinators, there were still 9 hospitals

who failed to attend the survey. The follow-up telephones demonstrated that they could not assign the responsible staff to fill the survey, or they are lack of relevant data. Thus it is very possible that the 41 participating hospitals may have relatively good backgrounds of disaster rescue than other 9 nonparticipation hospitals. Also, we suspect that the participating hospitals are better prepared in terms of disaster management than the non-participating hospitals. Secondly, due to the sample size (n = 41), it was possible that not all the significant difference of the mean score of each domain was tested statistically between different hospital categories (as illustrated in Table 3.1). Despite the limitation, the sample accounted for 52.1% of total hospitals that the study targeted, and did get a response rate over 80%. Thirdly, as the findings are self-reported by the respondents there may be a bias in their reporting. While the inclusion of official documents from Provincial Health Bureaus may have encouraged respondents to complete survey, this may have also been interpreted as an official assessment, thus leading some hospital representatives to overestimate their capability. Fourthly, due to ethical issues, the surveyed hospitals have to be anonymous which impedes comparison with their actual levels of preparedness. Finally, the study was undertaken only in one Province of China. And due to the limitation of funding and investigation time, stratified sampling was used in this study rather than investigating all the tertiary hospitals.

3.5 CONCLUSIONS

This study has identified considerable variability in the scope of hospitals' disaster resilience arrangements in Shandong China. The difference between tertiary A and tertiary B hospitals was also identified in essential areas. A framework was presented which may assist hospitals to better understand what constitutes effective hospital resilience. The framework may also assist hospitals to undertake a self-analysis or audit of their current plans and capacity, and to use this information for future planning. Clearly, more progress is still needed to improve hospital disaster resilience, especially the focus of community-wide disaster cooperation, on-site medical rescue, and hospital patient care surging capacity. It has been shown that hospitals need to take a more cohesive approach to be resilient in order to position themselves to be able to best cope with a potential disaster.

REFERENCES

1. Center For Strategic and International Studies: China's capacity to manage infectious diseases—global implications. In A Report of the CSIS Freeman Chair in China Studies Edited by: III CWF, Lu X. 2009. http://csis.org/files/media/csis/pubs/090325_freeman_china-capacity_web.pdf. Accessed on March 24, 2014
2. The United Nations Office for Disater Risk Reduction: Disater Redcution Report of the People's Republic of China. 2005. http://www.unisdr.org/2005/mdgs-drr/national-reports/China-report.pdf. Accessed on March 24, 2014.
3. Zhang L, Liu X, Li Y, Liu Y, Liu Z, Lin J, Shen J, Tang X, Zhang Y, Liang W: Emergency medical rescue efforts after a major earthquake: lessons from the 2008 Wenchuan earthquake. Lancet 2012,379(9818):853–861.
4. Kaji AH, Koenig KL, Lewis RJ: Current hospital disaster preparedness. JAMA 2007,298(18):2188–2190.
5. Barbera JA, Yeatts DJ, Macintyre AG: Challenge of hospital emergency preparedness: analysis and recommendations. Disaster Med Public Health Prep 2009,3(Supplement 1):S74.
6. Sauer LM, McCarthy ML, Knebel A, Brewster P: Major influences on hospital emergency management and disaster preparedness. Disaster Med Public Health Prep 2009,3(Supplement 1):S68.
7. Rose A: Defining and measuring economic resilience to disasters. Disaster Prev Manag 2004,13(4):307–314.
8. Albanese J, Birnbaum M, Cannon C, Cappiello J, Chapman E, Paturas J, Smith S: Fostering disaster resilient communities across the globe through the incorporation of safe and resilient hospitals for community-integrated disaster responses. Prehosp Disaster Med 2008,23(5):385–390.
9. Bruneau M, Chang SE, Eguchi RT, Lee GC, O'Rourke TD, Reinhorn AM, Shinozuka M, Tierney K, Wallace WA, von Winterfeldt D: A framework to quantitatively assess and enhance the seismic resilience of communities. Earthq Spectra 2003,19(4):733–752.
10. Cimellaro GP, Reinhorn AM, Bruneau M: Seismic resilience of a hospital system. Struct Infrastruct Eng 2010,6(1–2):127–144.
11. The concept of resilience: Understanding its origins, meaning and utility. [http://torrensresilience.org/images/pdfs/resilience%20origins%20and%20utility.pdf]
12. Organisation resilience: understanding the concept and its application. [http://torrensresilience.org/images/pdfs/organisational%20resilience.pdf]
13. Li X, Huang J, Zhang H: An analysis of hospital preparedness capacity for public health emergency in four regions of China: Beijing, Shandong, Guangxi, and Hainan. BMC Public Health 2008,8(1):319.
14. Hui Z, Jian-Shi H, Xiong H, Peng L, Da-Long Q: An analysis of the current status of hospital emergency preparedness for infectious disease outbreaks in Beijing, China. Am J Infect Control 2007,35(1):62–67.
15. Zhang Y, Wu Q, Hao Y: An analysis of the current hospital emergency responding capacity in the province of Heilongjiang. Chinese Public Health 2007, 23:345–346.
16. Yantao X: Assessment of hospital emergency management in the Beijing area. Prehosp Disaster Med 2011,26(3):180.
17. Xin YT, Xu KY: Hospital emergency management research in China: trends and challenges. Emerg Med J 2012,29(5):353–357.

18. Zhong S, Clark M, Hou X-Y, Zang Y-L, Fitzgerald G: Development of hospital disaster resilience: conceptual framework and potential measurement. Emerg Med J 2013. doi:10.1136/emermed-2012–202282
19. ZH G: Hospital Management. Beijing: People's Health Publishing House; 1990.
20. Norusis M: SPSS 16.0 guide to data analysis. Prentice Hall Press; 2008.
21. Zhang H: An evaluation study on secondary and tertiary care hospitals capabilities in publie health emergeney preparedness in Bejiing, China. PhD thesis of Chinese Peking Union Medical College; 2006.
22. Organisation resilience: understanding the concept and its application. [http://torrensresilience.org/images/pdfs/organisational%20resilience.pdf]
23. Rogers P: Development of Resilient Australia: enhancing the PPRR approach with anticipation, assessment and registration of risks. Aust J EmergManage 2011,26(1):54–59.
24. Kahan JH, Allen AC, George JK: An operational framework for resilience. J Homeland Sec Emerg Manage 2010,6(1):1–48.
25. Sternberg E: Planning for resilience in hospital internal disaster. Prehosp Disaster Med 2003,18(04):291–300.
26. Bruneau M, Reinhorn A: Exploring the concept of seismic resilience for acute care facilities. Earthq Spectra 2007,23(1):41–62.
27. Niska RW, Shimizu IM: Hospital preparedness for emergency response: united states, 2008. Natl Health Stat Report 2011, 2011:1–14.
28. Farmer JC, Carlton PK Jr: Providing critical care during a disaster: the interface between disaster response agencies and hospitals. Crit Care Med 2006,34(3):S56-S59.
29. Higgins W, Wainright C, Lu N, Carrico R: Assessing hospital preparedness using an instrument based on the Mass Casualty Disaster Plan Checklist: results of a statewide survey. Am J Infect Control 2004,32(6):327–332.
30. Shuai XH, Yang GL, Jiang LX: Earthquake disaster prevention and mitigation and emergency status in Japan. Earthquake 2004, 3:101–106.
31. International Strategy for Disaster Reduction: Hyogo framework for action 2005–2015: Building the resilience of nations and communities to disasters. In World Conference on Disaster Reduction: 2005. Hyogo, Kobe, Japan; 2005:18–22. http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish. pdf. Accessed on March 24, 2014
32. Schultz CH, Koenig KL, Noji EK: A medical disaster response to reduce immediate mortality after an earthquake. New Engl J Med 1996,334(7):438–444.
33. Auf der Heide E: The importance of evidence-based disaster planning. Ann Emerg Med 2006,47(1):34–49.
34. Hick JL, Hanfling D, Burstein JL, DeAtley C, Barbisch D, Bogdan GM, Cantrill S: Health care facility and community strategies for patient care surge capacity. Ann Emerg Med 2004,44(3):253–261.
35. Sapir DG, Panaccione VC: Health sector implications of the 1988 earthquake in Yunnan Province, China. Disasters 1992,16(2):145–151.

APPENDIX 3.1

Framework of evaluating hospital disaster resilience Framework of evaluating hospital resilience after Modified-Delphi consensus [1-11]

Domains	Sub-domains	Measurable indicators
Hospital safety[9-11]	1. Surveillance [1-9]	1.1 The surveillance events (e.g., abnormity in admission diagnosis, surveillance of emergency room patients and death with unknown causes)
		1.2 Analysis, report and share of surveillance information
	2. Hospital infrastructural safety and vulnerability [9-11]	2.1 Evaluation of hospital risks and vulnerabilities (e.g., Hospital vulnerability assessment, risks assessment, the strategy to evacuate and protect existing patients)
		2.2 The safety standard for hospital critical infrastructures to meet of high risks (e.g., for earthquake, flood, fire and isolation for infectious diseases)
		2.3 The alternative emergency energy and facilities for backup (e.g., power, water, oxygen and telecommunication)
Disaster leadership and cooperation [1-9]	3. Leadership [1-9]	3.1 Committee staff, workplace
	4. Disaster cooperation [1-9]	4.1 The crisis cooperation within hospital
		4.2 The cooperation with community facilities (e.g., other hospital facilities, government offices, media, and police, fire department, and other public utilities)
Disaster plans[1-9]	5. Plan system [1-9]	5.1 Plans for different kinds of disasters (for different single risk)
		5.2 The staff coverage of disaster plans within hospital
		5.3 The period of evaluating and revising the plan
	6. Operating procedures to execute the plan [1]	6.1 The plan initiation (e.g., The rapidity for staff, equipment can be in place when initiating the plan)
		6.2 The extent the plan can be execute
		6.3 Different responsive procedures for different disaster levels and phases

APPENDIX 3.1 *(Continued)*

Domains	Sub-domains	Measurable indicators
Disaster stockpiles and logistics management[1-9]	7. Disaster resources [1-9]	7.1 The stock quantity and types for different emergency resources (e.g., clean water, food, blood, emergency medical suppliers, portable medical equipment)
		7.2 The strategies for management of emergency resources(e.g. logistics and distribution, contracts with suppliers and other hospitals, adjusted standards for their usage)
	8. Emergency medication [1, 3, 7, 9]	8.1 The stock quantity and types for essential medications for various disasters
		8.2 The strategies for management of medications (e.g., drug-distribution plans, drug management policy)
Emergency staff [1, 5, 6, 9]	9. Constitution of emergency group [1, 9]	9.1 Staff constitution of emergency expert group (e.g., quantity, specialty, and title)
		9.2 Staff constitution of emergency expatriate team (e.g., quantity, specialty, and title)
	10. Staff management [9]	10.1 Staff protection and incentives (e.g., insurance, immunization, psychosocial support)
Emergency trainings and drills[1-4, 6]	11. Emergency trainings [1-4]	11.1 Different incident types for trainings
		11.2 The percentage of staff for training
		11.3 The contents of trainings (e.g., triage, emergency medical treatment, disaster management knowledge)
		11.4 The frequency of trainings
	12. Emergency drill [1, 2, 4, 6]	12.1 Different incident types for drills
		12.2 The methods for implementing drills (e.g., desktop drill, community-wide drill)
		12.3 The frequency of drills

APPENDIX 3.1 *(Continued)*

Domains	Sub-domains	Measurable indicators
Emergency critical care capacity [1, 4, 6, 9]	13. Disaster surge capacity [1, 4, 9]	13.1 Surge capacity of emergency space (The surge rapidity, proportion and strategies for emergency space, emergency beds)
		13.2 Surge capacity of emergency resources (The surge rapidity, proportion and strategies for emergency equipment, medication and resource)
		13.3 Surge capacity of emergency staff (The surge rapidity, proportion and strategies for emergency staff)
	14. Disaster response procedures [6, 9]	14.1 Hospital internal rapid assessment (e.g., evaluate the loss of manpower, beds, equipment after disasters)
		14.2 Hospital mass-casualty triage protocol
		14.3 The procedures to identify, prioritize, and maintain essential functions(e.g., cancellation of elective admissions, early discharge of patients, making new medical quality standard during disasters, extra protection for vulnerable population)
	15. On-site rescue [1, 6]	15.1 The quantity and types of equipment for on-site rescue
		15.2 Equipment for referral and counter-referral of special patients
		15.3 Communication equipment for on-site rescue
	16. Hospital treatment [1]	16.1 Emergency medical treatment place and conditions
		16.2 The types and quantity of hospital emergency medical treatment equipment
		16.3 Equipment for different types of diseases
Recovery mechanism [9]	17. Recovery and report [9]	17.1 Hospital reconstruction and recovery mechanism
		17.2 The strategies for community recovery
		17.3 The evaluation report

REFERENCES

1. Li X, Huang J, Zhang H. An analysis of hospital preparedness capacity for public health emergency in four regions of China: Beijing, Shandong, Guangxi, and Hainan. *BMC Public Health*. 2008;8(1):319.
2. Braun BI, Wineman NV, Finn NL, et al. Integrating hospitals into community emergency preparedness planning. *Ann Intern Med*. 2006;144(11):799-811.
3. Braun BI, Darcy L, Divi C, et al. Hospital bioterrorism preparedness linkages with the community: improvements over time. *Am J Infect Control*. 2004;32(6):317-326.
4. Kaji AH, Lewis RJ. Hospital disaster preparedness in Los Angeles county. *Acad Emerg Med*. 2006;13(11):1198-1203.
5. Kollek D, Cwinn AA. Hospital emergency readiness overview study. *Prehosp Disaster Med*. 2011;1(1):1-7.
6. Niska RW, Shimizu IM. Hospital Preparedness for Emergency Response: United States, 2008. Natl Health Stat Report; 2011:1-14.
7. Higgins W, Wainright C, Lu N, et al. Assessing hospital preparedness using an instrument based on the Mass Casualty Disaster Plan Checklist: results of a statewide survey. *Am J Infect Control*. 2004;32 (6): 327-332.
8. Thome CD, Levitin H, Oliver M, et al. A pilot assessment of hospital preparedness for bioterrorism events. *Hospital*. 2006;200 (299):300.
9. World Health Organization. Hospital emergency response checklist-An all-hazards tool for hospital administrators and emergency managemers. The Regional Office for Europe of the WHO; 2011.
10. Pan American Health Organization, WHO. Hospital safety index: evaluation forms for safe hospitals. Washington DC: PAHO; 2008.
11. World Health Organization. Safe hospitals in emergencies and disasters. World Health Organization (WHO) Regional Office for the Western Pacific; 2010.

APPENDIX 3.2 QUESTIONNAIRE (ENGLISH TRANSLATION VERSION)

Questionnaire for assessment of disaster resilience capability in tertiary hospitals of Shandong Province

Introduction note (please read first before filling the form)

1. Public emergencies and disasters in the questionnaire refer to events that suddenly happened and can cause serious impact to the society, which require emergency measures to be taken. These events include natural disasters (e.g., earthquakes, floods), disasters arising from accidents (e.g., transportation incidents, environmental pollution), public health incidents

(e.g., emerging infectious diseases, food poisoning) and public security incidents (e.g., terrorism).

2. Fill method: There are two types of questions: (1) choice questions: Unless it is marked with "this question has multiple choices", these questions are single choice (i.e. select one answer), please choose the option that can meet the hospital's situation, which is after each question (e.g., ①②③) / by tick "√"; (2) fill in the blank: please fill out the relevant data / content into the underscored place after each question. Note the logical question to jump to the next question.
3. Please be sure to complete the form within the required time. After its completion, please report them simultaneously both via e-mail and postal.

Thank you for your assistance and support to the investigation!

Hospital name _____ fill date _____ month ____date 2012

The informant (signature) _____Audit dean (signature) _____Official seal: (stamp)

A. The general situation relevant to emergency medicine

1. Hospital level: Tertiary (e.g., A, B, C).
2. Hospital location (in details to the county, city, and district):
3. Hospital attribution: ①government health administrative office ②industry hospital ③others
4. Hospital type: ①general hospital ②specialty hospital ③others
5. Hospital mission: ①be assigned regional disaster rescue mission ②not-assigned the mission

B. Hospital safety

6. Whether the hospital establishes a syndromic surveillance and early warning system for public health emergencies? ①Yes ②No;
   - 6.1 The syndromic that need to be surveillance, report and early warning include:
   - 6.2 Whether develop and require that physicians on duty report any suspicious cases to the hospitals' presidents? ①Yes ②No;

7. Whether the hospital has direct online reporting system of surveillance information and suspicious symptoms? ①Yes ②No;

   7.1 Whether the hospital could analyze surveillance data regularly and share this system with the local health authority? ①Yes ②No;

8. Is there any evaluation of types and impact of the potential risks to hospitals in its location? ①Yes ②No;

   8.1 When the disaster occurred, within the hospital is there any hazards identification system for different types of risks? ①Yes ②No;

   8.2 When there is hospital internal risk, are there any strategies for hospitals to evacuate and protect existing patients? ①Yes ②No;

9. Is there any evaluation of the safety standards of hospital's critical infrastructures? (e.g., construction safety standards, safety level of resistance to earthquakes, fires and floods). ①Yes ②No;

   9.1 If yes, were the critical infrastructures built to meet or excess the local criteria of resistance to earthquake? ①Yes ②No;

   9.2 If yes, were the critical infrastructures built in a higher position in the area to prevent floods? ①Yes ②No;

   9.3 If yes, was the critical medical equipment located in a higher level of the building to prevent floods? ①Yes ②No;

   9.4. If yes, is there any consideration of the safety standard for the risk of fire? ①Yes ②No;

   9.5 If yes, is there any consideration of using isolated pathways and designated areas for infectious diseases within the hospital? ①Yes ②No;

10. When disaster occurred, are there any alternative emergency energy and facilities for backup (including power, water, oxygen and telecommunication)? ①Yes ②No;

C. Hospital disaster leadership and cooperation

11. Is there any disaster committee or disaster group within hospital that is responsible for public emergencies? ①Yes ②No;

    11.1 Is there any official document that has been used to establish hospital disaster committee or disaster group? ①Yes ②No;

12. Is there any department within the hospital that has been assigned responsibility for the work relevant to emergencies? ①Yes ②No;

    12.1 Is there any official document that has been used to assign emergency relevant work to this department? ①Yes ②No;

13. Is there any coordinating meeting with key staff from different hospital departments during emergencies? ①Yes ②No;

14. Is there any public and mass media communication protocol that can be used for communication during emergencies? ①Yes ②No;

15. Has the hospital attended regional coordinating meeting with other emergency departments during emergencies, such as CDC (Center for Disease Prevention and Control), pre-hospital emergency system, healthcare facilities, blood and resource center, and local government? ①Yes ②No;

D. Hospital disaster plan

16. Is there any general disaster plan and relevant document in place for preparedness of public emergencies? ①Yes ②No;

    16.1 Please illustrate the document name of the disaster plan?

17. Are there any specific disaster plans based on the specific requirements of a single hazard, such as infectious diseases, internal medical accidents, public health emergencies, natural disasters, bio-terrorism and nuclear terrorism, and others? ①Yes ②No;

    17.1 Please illustrate the document name of the specific disaster plans?

18. Is there any protocol to initiate the plan, so as to guarantee the hospital be in place to face emergencies immediately, (i.e., guarantee staff, equipment and resources are in place immediately)? ①Yes ②No;
19. From the experience of the hospital dealing with the past public emergencies (i.e., mass casualty incident, disasters, pandemics), whether the hospital could operate in accordance with the disaster plan during emergencies? ①Yes ②No;
20. Is there any classification response system to cope with different levels and different phases of events? ①Yes ②No;
21. Is there any evaluation and revision of the disaster plans in the last two years? ①Yes ②No;

22. Is there any dissemination of the content of disaster plans to the key staff (e.g., through regular meetings or training)? ①Yes ②No;

E. Emergency stockpiles and logistics management

23. Are there any stockpiles of various types of emergency drugs within hospitals? ①Yes ②No;

    23.1 If yes, please illustrate the type names and quantities of these stockpiled drugs?

24. Are there any stockpiles of various types of emergency materials (e.g., food, water, stretcher, and tourniquet)? ①Yes ②No;

    24.1 If yes, please illustrate the type names and quantities of the stockpiled materials?

    24.2 Whether the hospital has the following personal protective equipment (PPE) *(multi-choices)*?

    ①biohazard protective suits; ②goggles; ③ventilator; ④N95 Masks

25. When there is mass casualty incident, whether the hospital could be able to load and deliver emergency drugs for on-site rescue? ①Yes ②No;

    25.1 If yes, please illustrate the names and quantities of the emergency drugs that could be loaded and delivered for on-site rescue?

26. Whether the hospital has the following strategies for management of drugs and materials?

Strategies for management of drugs and materials?	**Yes**	**No**
26.1 Drug-distribution plans to identify distribution priority of drugs during crisis	□	□
26.2 Signed contracts with emergency drug-supplies to provide drugs during emergencies	□	□
26.3 Signed Memorandum of Understandings (MOUs) with other hospitals to share emergency drugs during emergencies	□	□
26.4 Share and obtain these materials from relevant industries during emergencies	□	□
26.5 Share and obtain these materials from other hospitals during emergencies	□	□
26.6 Others: (please illustrate)	□	□

F. Emergency Staff

27. The constitute (i.e., specialty and numbers) of hospital experts group (refer to those members within the hospital that are involved in development of the emergency plans and specific emergency medical treatment)

① General surgical treatment_____persons, including senior persons;

② General medical treatment____persons, including senior____persons;

③ Neurosurgery persons, including senior_____persons;

④ Bone surgery_____persons, including senior_____persons;

⑤ Burn persons, including senior_____persons;

⑥ Psychological persons, including senior_____persons;

⑦ Emergency Department persons, including senior_____persons;

⑧ ICU persons, including senior_____persons;

⑨ Nosocomial infections persons, including senior_____persons;

⑩ Total experts_____persons, including senior_____persons;

28. Is there any emergency staff that could be dispatched during disasters for the on-site rescue? ①Yes ②No;
If yes, please fill the constitute (i.e., specialty and numbers) of emergency staff that can be dispatched

① General surgical doctors,_____persons, general surgical nurse _____persons;

② Therapeutic,_____persons, general medical nurse_____persons;

③ Neurosurgeon doctors____persons, neurosurgery nurses____persons;

④ Orthopedic surgeon doctors_____persons, orthopedic surgeon nurse _____persons;

⑤ Burn treatment doctors_____persons, burn treatment nurses _____persons;

⑥ Psychological doctors_____persons;

⑦ Emergency department doctors_____persons, emergency nurses _____persons;

⑧ ICU doctors_____persons, ICU nurses_____persons;

⑨ Infections control doctors_____persons, infections control nurses _____persons;

⑩ Manager people _____ persons, including managers _____ persons, information people _____ persons; logistics _____ persons; and other relevant personnel _____ persons

⑪ Total doctors persons, total nurses persons;

29. Whether the hospital has the following incentive and protective strategies for management of emergency staff?

Incentive and protective strategies for emergency staff?	Yes	No
29.1 Incentive strategies for emergency staff	□	□
29.2 Vaccination for emergency staff and their family members	□	□
29.3 Insurance for emergency staff	□	□
24.4 Others (please illustrate):	□	□

30. Whether the hospital has the following incentive strategies? (Can be multiple-choices)

① increase the salary; ②increase the vacation; ③priority for hiring and position promotion; ④Honors; ⑤issue the grant

G. Emergency critical care capability

Hospital treatment

31. The total number of hospital beds_____sheets;

31.1 Among them, the number of licensed beds_____sheets;

31.2 The number of beds in emergency department or emergency care center_____sheets;

31.3 The number of isolation beds_____sheets;

31.4 The number of orthopedic beds_____sheets;

31.5 The number of suspension bed for burns_____sheets;

31.6 The number of emancipated bed for burns_____sheets;

31.7 The number of surgery rooms_____;

31.8 The number of hyperbaric oxygen chambers_____;

32. The number of intensive care beds_____sheets;

    32.1 The number of breathing machines_____;

    32.2 The number of vital signs monitors_____;

    32.3 The number of defibrillator machines_____;

    32.4 The number of cardiac resuscitation devices_____;

    32.5 The number of CRRT devices_____;

33. Whether the hospital has capacity (e.g., space, beds and experts) for treating mass casualty of incidents (i.e., here mass casualty treatment capacity refers to each hospital is to assess itself on its capacity to accept at least 30 patients of the same disease within a short period)? ①Yes ②No;

    33.1 Whether the hospital has capacity (e.g., space, beds and experts) for treating general mass casualty of trauma? ①Yes ②No;

    33.2 Whether the hospital has capacity (e.g., space, beds and experts) for treating mass casualty of infectious diseases? ①Yes ②No;

    33.3 Whether the hospital has capacity (e.g., space, beds and experts) for treating mass casualty of blast injury, gunshot wounds and crush injury? ①Yes ②No;

    33.4 Whether the hospital has capacity (e.g., space, beds and experts) for treating mass casualty of acute chemical poisoning? ①Yes ②No;

    33.5 Whether the hospital has capacity (e.g., space, beds and experts) for treating mass casualty of radiation issues? ①Yes ②No;

Hospital surge capacity

34. When disaster occurs, is there any internal evaluation mechanism for rapid assessment of the available emergency resources and the disaster losses? (i.e., manpower, equipment, number of emergency beds)? ①Yes ②No;

35. Are there any prepared spaces and conditions (e.g., electricity, oxygen, water, heat) in place to temporary surge numbers of emergency beds? ①Yes ②No;

35.1 If yes, are there any plans and work procedures for surging emergency beds? ①Yes ②No;

35.2 The maximum surge capacity of emergency beds are_____sheets (within 24 hours)

36. Are there any procedures and strategies to vacate part of the occupied emergency beds for treating the sick and wounded from emergency events according to the requirement? ①Yes ②No;

36.1 When emergency occurs, according to the instruction from health administrative departments and the actual situation of admitted patients, within 24 hours, the hospital can maximum vacate the occupied emergency beds of sheets?

37. Whether the hospital has a wide variety of flexible procedures for surging beds capacity when it faces the emergencies?

Surge procedures for emergency beds	**Yes**	**No**
37.1 cancellation of elective admissions	□	□
37.2 early discharge of patients	□	□
37.3 transfer patients to primary health care and other facilities	□	□
37.4 others (please illustrate):	□	□

38. Whether the hospital has a wide variety of flexible procedures for surging emergency staff capacity when it faces the emergencies?

Surge procedures for emergency staff	**Yes**	**No**
38.1 training and transferring non-critical care staff to support critical care	□	□
38.2 recalling all the off-work staff back to work	□	□
38.3 rehiring retired staff	□	□
38.4 sharing staff from other hospitals	□	□
38.5 using volunteers or temporary employers	□	□
38.6 suppling living places for staff		
38.7 others (please illustrate):	□	□

39. Are there any mass-casualty triage procedures for admission of patients who require urgent critical care during disasters? ①Yes ②No;

On-site Rescue

40. Whether the hospital has its own ambulances? ①Yes ②No;
    - 40.1 If yes, are there any ward-type ambulances? ①Yes ②No;
    - 40.2 If yes, are there any negative pressure isolation ambulances? ①Yes ②No;
    - 40.3 Whether the hospital has on-site command vehicle? ①Yes ②No;
41. Whether the hospital has rescue helicopters and access to a helicopter landing pad? ①Yes ②No;
42. Is there any on-site communication equipment for data transmission, video-audio connection, and remote consultation? ①Yes ②No;
43. Whether the hospital could organise an independent rescue team that is equipped with emergency package of supplies for living 3 days (the teams include those health administrative departments or other departments assigned to construct based on the hospital)? ①Yes ②No;
    - 43.1 If yes, please illustrate the number of staff for the rescue teams, and their departments and specialty:
    - 43.2 If yes, are the rescue teams equipped with portable medical equipment equipped (e.g., portable breathing machine, ECG monitoring machine, and the X-ray machine? ①Yes ②No;
44. Whether the hospital has 'portable hospital' or the capability to support field surgery, and other critical care in the field, which is similar to the function of ICU (using vehicles which are equipped with beds and portable medical equipment)? ①Yes ②No;

H. Emergency training and drills

45. Are there any disaster or emergency training programs? ①Yes ②No;
46. Are there any disaster or emergency drills? ①Yes ②No;
47. If yes, are there any disaster training programs and drills treating the following emergency types respectively during 2011-2012?

Types for disaster training programs and drills	has training	has drills
47.1 infectious disease	□	□
47.2 mass casualty incidents (e.g., natural disasters)	□	□
47.3 career poising and food poising	□	□
47.4 bio-terrorism and nuclear terrorism	□	□

48. Are there any disaster training curriculums? ①Yes ②No;

48.1 If yes, were the training curriculums updated regularly? ①Yes ②No;

49. In 2011-2012, is there any emergency training including the following content?

Content of emergency trainings	Yes	No
49.1 basic skills for the treatment of trauma	□	□
49.2 cardiopulmonary resuscitation	□	□
49.3 trachea cannulation	□	□
49.4 transfer of casualties	□	□
49.5 triage	□	□
49.6 disaster management	□	□
49.7 others (please illustrate) :	□	□

50. Is there any emergency or disaster training regularly every two years? ①Yes ②No;

51. Are there any disaster drills regularly every two years? ①Yes ②No;

52. Are there any drills the hospital cooperating with all the other emergency facilities of the community? ①Yes ②No;

I. Recovery and reconstruction

53. Is there any mechanism of after-event evaluation report? ①Yes ②No;

53.1 If yes, is the following content need to be included in the evaluation report?

Evaluation content	Yes	No
53.1 local high risks re-evaluation	□	□
53.2 hospital capability evaluation	□	□
53.3 hospital vulnerability evaluation	□	□
53.4 experience and lessons that have been learned	□	□
53.5 the adaptation strategies in the future	□	□
53.6 others (please illustrate):	□	□

54. Is there any special department that would be assigned to be responsible for the work relevant to recovery and reconstruction? ①Yes ②No;

55. Are there any specific channels of investing money, transferring staff, and purchasing equipment for recovery phases after the event? ①Yes ②No;

56. Whether the hospital has been involved or would be involved in the health related work of the affected communities?

Be involved in the health related work of the affected communities?	Yes	No
56.1 be involved in the design of the recovery strategies for the community	□	□
56.2 health evaluation of the community	□	□
56.3 health intervention to the community	□	□
56.4 rehabilitation for the victims	□	□
55.5 psychological consultation for relevant people	□	□
55.6 others (please illustrate):	□	□

CHAPTER 4

A Qualitative Examination of the Health Workforce Needs During Climate Change Disaster Response in Pacific Island Countries

Michele Rumsey, Stephanie M. Fletcher, Jodi Thiessen, Anna Gero, Natasha Kuruppu, John Daly, James Buchan, and Juliet Willetts

4.1 BACKGROUND

The intersection between climate change, disasters, health and development is an area of concern for the development community [1-3]. A growing body of evidence links human-induced global warming to an increased number of observed extreme weather events, particularly heat waves and extremes in precipitation, with 'plausible' evidence for a link to an increased severe storm potential [4]. Projections for tropical cyclone frequency for the Pacific follow global trends—that is, less frequent, but more intense, tropical cyclones by the end of the 21st century [5]. There is growing political commitment to integrate health considerations into climate change mitigation and adaptation efforts, at different national and regional levels, but these are still limited in the Pacific region [6]. Regional efforts to address climate change and health include the 'Regional framework for action to protect human health from effects of climate change in

the Asia and Pacific region' and the 2009 Pacific Islands Forum's call for immediate action to address climate change issues in Pacific Island Countries (PICs) [7]. These efforts were intended to guide regional and national action towards reducing the potential burden of diseases linked to the effects of climate change in the region. The World Health Organization (WHO) regional offices in South East Asia (SEARO) and Western Pacific (WPRO) have continued to engage in and support regional planning activities on climate change and health, resulting in recommendations for action by Member States and WHO secretariat [6]. One of the key priorities identified by regional stakeholders is the need for better understanding of how climate change will impact on health system's response to emergencies and disasters [8].

The health-care system is directly affected by disasters, and the community is reliant on this system to meet their health needs during and after disasters. It is therefore important that the health sector has adequate capacity to plan for and to respond to post-disaster needs [9,10]. The impact of disasters on population health requires a range of activities to be implemented by the health workforce, demanding various skills and competencies [9]. These include skills in emergency surgery and medical care, rapid diagnosis, disease surveillance, prevention and containment, psychosocial support for affected communities, health education and promotion, creating temporary facilities, conduct monitoring and evaluation, providing medical relief supply management/ control and other public health interventions [11-14]. Assessing the vulnerability of the health sector is essential in order to manage future risks, under a changing climate [2,15,16].

The purpose of this research was to assist in identifying factors for enhancing long-term adaptive capacity and thereby inform policy makers and disaster response practitioners on processes required for improved disaster response in the face of climate change. The research defined 'adaptive capacity' as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences [17]. As part of a wider research into the adaptive capacity of the full disaster response system, the capacity of the health sector across the four case study PIC countries was assessed. The concept of 'adaptive capacity' is complex and contested, thus, the research team drew on literature across several relevant disciplines to define a range of potential key determinants of adaptive capacity to support exploration of the concept, and are further described in the Methods section. WHO asserts that the capacity of the health-care sector to respond to disasters is a determinant of overall adaptive capacity of human resources for health in disaster response in PICs [18,19].

This paper looks closely at the health-care capacity of the PICs to respond to disaster under a changing and variable climate, based on findings from fieldwork and stakeholder interviews in Australia and four PICs: Cook Islands, Fiji, Samoa and Vanuatu.

4.2 METHODS

The research methods are described only briefly here, and may be found in detail elsewhere [20]. In summary, a qualitative research methodology was used, and included desktop reviews, individual and group interviews, and in-country workshops. The research process was guided by a Project Reference Group (PRG) comprising key stakeholders in Australia and the Pacific as a form of structured stakeholder engagement and to guide the re- search process, outputs and uptake of results. The concept of adaptive capacity was used to identify the factors enabling and constraining individual organizations and the broader system of response [21].

A conceptual framework by Gero et al. [20] guided the research, leading to efforts to both define and understand the disaster response systems, and to identify the most significant determinants affecting adaptive capacity and how these might be influenced to reduce disaster impacts on responding agencies and the wider population. Specific determinants of adaptive capacity were used to assess the DRS, and were drawn from literature that spans Earth System Governance [22], climate change adaptation [23], health resources [1,18,19], resilience in institutions [24] and practice theory [25], several of which are applicable to the health-care setting.

Key determinants of adaptive capacity were identified as being inter-organizational, intra-organizational, objective and subjective. Among these, the intra-organizational—objective determinants of leadership, management and governance structures, technical capacity, tools, methods and approaches, health workforce education, training and continuing competence [18,26-29], human resource for health governance and management systems [18,19], are relevant to this paper.

4.2.1 Country Selection

Four PICs (Cook Islands, Fiji, Samoa and Vanuatu) were investigated in detail to provide more of a regional viewpoint. These countries were selected with

the aim to include a variety of geographical settings (including Melanesia and Polynesia), varied policy landscapes (regarding climate change, disaster and health-related policies and plans), a mix of countries with recent significant climate-driven disasters and those in the more distant past (relating to degrees of memory and levels of preparedness), and countries that experience tropical cyclones as an example of a rapid onset disaster. The scope of the study was limited to health-related humanitarian needs and as such researchers were interested in obtaining a mix of countries including high and low human resources for health (HRH) density. Development indicators (for example, varied Human Development Index—see UNDP 2011 [30]) were also used as a criterion for selection to include countries at different stages of development. A full account of the methodology and further background on each country can be found in Gero et al. [20].

4.2.2 Data Collection and Analysis

Relevant organizations in each country were identified with the assistance of the PRG, with additional organizations identified through a snowball sampling technique [31]. Over 90 interviews were undertaken with senior officials from government and non-government organizations (NGOs), UN agencies, donors and regional organizations involved in disaster response from Australia, New Zealand and the four PICs, during May to July 2012. The interview style, developed with the guidance of the PRG, was de- signed to appreciate the cultural differences and the need for flexibility when interviewing people from various cultural backgrounds. The semi-structured interview guide was informed by the conceptual framework. Examples of health-related questions are provided below as well as the range of organizations interviewed.

Examples of health-related questions:

1. How was the Ministry of Health involved in the coordination of in-country health staff during the disaster?—if/how did this link in with incoming support?
2. How did incoming Australian or overseas support affect your organization's ability to respond?
3. How is the health sector involved in the decision-making process regarding requesting external assistance? What role do they play?
4. Does your country have policies in place to coordinate HRH in times of disaster? Are there registration issues for incoming health professionals?

5. How do you think the national system of disaster response will cope if disaster frequency and intensity increases?

Examples of organizations included in interviews:

Australian Organizations:

- AusAID
- The Australian Council for International Development (ACFID)
- The Australian Civil Military Centre
- Australian Defence Force
- Australian Red Cross
- NGOs including: Oxfam, World Vision, Save the Children, CARE, Caritas, Plan and RedR, ADRA

Pacific Organizations:

- National Disaster Management Offices
- National Climate Change Offices
- Ministries of Health, Environment, Finance, Foreign Affairs (among others)
- National Red Cross Societies
- Faith-based organizations
- NGOs of both local and international origin
- Donors (for example, AusAID, New Zealand Aid Programme)
- United Nations (UN) agencies
- Regional organizations (for example, Secretariat of the Pacific Community (SPC))

Following in-country work, key informant interview transcripts were subjected to an inductive thematic analysis [32], for general patterns and emerging issues from participants' explanations and descriptions [33]. Interview transcripts were coded for specific themes based on the conceptual framework, including triangulation of data from multiple sources [34] using the qualitative software NVivo 10. Written informed consent was obtained from all participants and only quotes from those who gave consent have been included in this report. This research was approved by the Human Research Ethics Committee of the University of Technology Sydney and by the Ministry of Health in each of the four PIC countries.

4.3 RESULTS AND DISCUSSION

The findings presented are reflective of the intra-organizational objective determinants of adaptive capacity which are specific to the health sector. The following themes from the analysis of the findings are suggested as being essential for the health-care system, in the four case study PICs, to effectively adapt disaster response in the cli- mate change context. The three thematic areas are:

- Health workforce governance, policy and management;
- Health-care capacity and skills;
- Human resources for health training and workforce
- development.

A summary of key regional health-care capacity issues identified in the four PIC countries are grouped under these three areas and presented in Table 4.1. Critical aspects of each of the three areas are discussed in more detail in the following sections of the paper.

4.3.1 Health Workforce Governance, Management and Policy

Health workforce governance, policy and management are required for sustained workforce contributions to improved population health outcomes, including HRH capacities to address disasters [18,19]. Governance has been described as a determinant of adaptive capacity of the health sector for disaster response [1,35]. This requires clear policies and a cross-sectoral national coordination or formal mechanisms of governance including health planning, stakeholder coordination, registration and coordination of in-coming overseas health workforce. Management capacity-building policies and structures should be in place and networks and partnerships of relevant committed leaders and stakeholders should be established and under pinned by the relevant operational processes [15,18,19].

4.3.2 Health-Care Governance

For an adaptive policy environment and effective implementation of plans, the health sector requires a suite of governance-related functions, including clear mandates, effective decision-making and response to community-identified

TABLE 4.1 Summary of key regional health-care capacity issues for disaster response

	Cook Islands	Fiji	Samoa	Vanuatu
Health workforce governance, management and policy				
Health-care governance	No clear guidelines for the coordination of in-coming health personnel. Mechanisms being developed to deal with this.	In-coming health personnel were usually coordinated through the UNOCHA/PHT system.	Existing guidelines for registration of in-coming health professionals, but not always followed.	No clear guidelines for the coordination of in-coming health personnel. Policies were needed to govern this process during disasters.
Health-care management systems	Health sector is a key stakeholder in the DRS and well organized and has seen improvements since the clarification of roles and responsibilities.	Health sector is a key stakeholder in the DRS and actively involved in disaster coordination. Health sector coordination functioning well.	Health sector is a key stakeholder in the DRS however internal issues may be affecting the strength of their coordination and involvement.	Health sector is a key stakeholder in the DRS however lacks coordination within the sector and with external partners needs to be improved.
Health-care policy environment	Policy in place to guide health workforce. Knowledge of policies affected by high staff turnover rates.	Generic policies and processes in place but need to be more clearly defined for specific disasters.	Clearly defined policies and processes in place, supported by National Development Strategy.	Lack of clear policies and guidelines for health workforce coordination.
Health-care capacity and skills				
Human resources for health capacity	Clear leadership and strong partnerships with NGOs and donors; health workforce and capacity inadequate particularly in times of disaster.	Strong leadership and external support systems from government and donors; health workforce capacity is stretched especially in times of disaster.	Strong leadership and external support systems from government and donors. Lack of cohesion within health sector limits effective utilisation of resources.	Internal leadership needs strengthening and relies heavily on external support. Limited capacity to respond to disasters against limited HRH and resources.
Health workforce capacity and skills	Inadequate capacity to address psychosocial needs.	Inadequate capacity to address psychosocial needs.	Inadequate capacity to address psychosocial needs.	Inadequate capacity to address psychosocial needs.

TABLE 4.1 *(Continued)*

	Cook Islands	Fiji	Samoa	Vanuatu
Human resources for health training, competencies and workforce development				
Health workforce education, training and development	Some level of disaster training available for health workforce. Desktop and field simulations or training programs annually. Access to training for some levels of staff is an issue. Need for a nursing education Institution in-country.	Disaster training available and included in nursing curriculum. Access to training for some levels of staff an issue.	Nursing and allied health staff actively involved. Task-shifting and multi-tasking encouraged. Low intakes in nursing and medical programs undermining workforce development. Triage and emergency medical care, post-trauma counselling were critical areas for training.	Health workforce actively involved, but needs to improve skills to deal with climate sensitive diseases. Disaster training available and included in nursing curriculum. Additional training for village health workers and traditional birth attendants needed.

DRS = disaster response system; HRH = human resources for health; NGO = non-governmental organization; UNOCHA/PHT = United Nations Office for the Coordination of Humanitarian Affairs/Pacific Humanitarian Team.

strengths [1]. A greater understanding of governance in the health-care context can provide opportunities to strengthen health sector policy and response action to the effects of climate change [1]. WHO defines leadership and governance as the existence of a strategic policy framework as well as effective oversight, coalition building, regulation, attention to system design, and accountability [6]. In the context of this study health governance specifically relates to the set of rules that define the responsibilities of health system actors, how they operate, and how they relate to one another [36]. The interviews as part of this re- search found two very important health-care management issues: the coordination and management of incoming (overseas) health workforce; and the protection and management of health staff affected by disasters and involved in disaster response.

4.3.3 Health-Care Management Systems

One of the key concerns expressed by both Australian and the PIC respondents was the coordination and registration of in-coming international health personnel in times of disasters. This was necessary to ensure timely external assistance, minimize duplication of scarce resources, provide a transparent process, and maximize effectiveness of health personnel. Studies have revealed that these elements are essential for the effectiveness of international disaster responses, and require the development of policies and agreements against agreed criteria as part of disaster preparedness on an international, bilateral and national level [37].

There were different approaches to the coordination of incoming international health personnel in the four PICs. In the Cook Islands, guidelines for the coordination of incoming health personnel require clarification. In normal times incoming personnel follow a registration protocol; however, in times of disaster the process was reportedly unclear. This has resulted in a recent review of legislation around international disaster response, calling for stricter regulation in this area [38]. For instance, according to one respondent, the request for international health staff goes through the Disaster Council and the Disaster Committee, who would then advise the Ministry of Health (MOH) of who is coming. However, another government respondent felt that while the requests go through the health ministry, the process can sometimes be informal and can result in fragmented communication, as evidenced by the following quote. “Informally all requests [for] incoming health workers go to the MOH;

[however] it doesn't always work as it can be an informal process across most sectors, which can lead to lack of sectors talking to each other". According to Bremer [37], policy making related to disaster response must be conducted in the disaster planning phase in both receiving and donor countries, since there is little time for policy making and implementation of rules during the acute phase of a disaster. These policies should be carefully developed to guide interventions that are based on commonly agreed upon criteria [37].

However, the absence of policies to guide international HRH in some PICs could be due to the fact that in recent times there has not been a need for international health personnel to assist with disaster response. The infrequency of larger scale disasters impedes the development of an evidence base to inform public health preparedness strategies [39]. One recent example of a disaster requiring overseas health workforce support in the Pacific was during the 2009 tsunami in Samoa [40]. The Pacific Humanitarian Team (PHT) includes, as members all organizations that have a mandate and the capacity to respond to a disaster in the Pacific region. The PHT provides support to government coordination efforts during a disaster response following a request for assistance, and was a key player in the 2009 tsunami response [40]. Both Vanuatu and Fiji respondents indicated that they relied on the PHT/UN Cluster system to assist with provision of health personnel in times of disaster. Samoan respondents indicated that a system was in place for the registration of in-coming health professionals. However, problems have been reported with this process, mainly because some NGOs were either unaware of the need to register or chose to bypass the system. One Samoan respondent suggested that an acceptable approach would be that medical NGOs and volunteers coming from overseas should link directly with the local MOH for a centralized approach in order to avoid duplication of roles. However, there is "[n]eed for a new fast circuit approach to facilitate the registration and checking of qualifications of health workers at the time of disasters" (OUM, Samoa).

In trying to address issues with in-coming health personnel, disaster response stakeholders have put forward a recommendation that the relevant Emergency Management Office should work closely with the UN Office for Coordination of Humanitarian Affairs (UNOCHA) and other external organizations to ensure that all personnel are registered and that a proper register of incoming support is maintained. This will ensure that in-coming personnel are properly screened and facilitate quicker immigration and customs processes [37]. International donors and Australian NGOs indicated that their provision of HRH for humanitarian response is guided by minimum global standards. Ministries of Health

in each country should work with external partners to manage registration of incoming health personnel effectively.

The other critical issue of governance involved limited systems for the protection and management of health staff affected by disasters. This was identified as impacting the health workforce's ability to respond effectively, since they were usually first responders in all countries, and had to conduct disaster initial assessments.

Some international organizations recognized that disasters impact individual health workers when their families, friends or homes are directly affected, placing additional demands and challenges on health workers [10]. Appropriate support systems would ensure that health workers are cared for and motivated in conducting this essential health function. Efforts and alternative sources that are being investigated to support human resource capacity were described by participants. In Samoa, for example, "private doctors and nurses are called in to assist in times of disasters" (Govt. Rep, Samoa).

The pre-existing HRH shortage in the Cook Islands reportedly resulted in existing personnel working extremely long hours. However there was no financial support or benefits for working overtime. Additionally, staff were not insured, so in the event of injury or death in the line of duty there was no redress. Similar issues were identified by respondents from Fiji and Samoa who indicated that health personnel were among the first responders, arriving in the disaster area while it was still relatively unsafe. Since health personnel are usually among the first responders to disasters, there needs to be stronger support systems in place to protect their wellbeing during times of disaster. This does not only have implications for response personnel's job security, but also for occupational safety and health, insurance and indemnity [41,42]. The provision of adequate pay and adequate indemnity for health-care staff involved in disaster response have been identified as essential motivators for Australian relief personnel [41]. Unfortunately these realities do not translate to their Pacific Islander counterparts due to pre-existing disparities in health-care financing and staff incentives. Efforts should be made to improve conditions for PIC counterpart health workers.

4.3.4 Health-Care Policy Environment

Interviews in the four PICs revealed evidence of a mixed policy environment across countries for the coordination of HRH for disaster response. For

example, in Fiji a contingency plan for disaster response and coordination of health staff was in place, including legislation to empower key individuals to make decisions in times of disasters. In the Cook Islands, a health disaster policy was in place to provide directions for both on-duty and off-duty staff during disasters, however there was limited knowledge of policies due to high staff turnover rates. The Samoa National Health Service (NHS) has a disaster plan which outlines staff responsibilities, which is disseminated down to the divisional level of the health sector that work closely with communities. The Samoan NHS plan makes provision for the involvement of the private medical practitioners and the Samoa Red Cross Society. Conversely, there was a lack of clear policies and guidelines for health workforce coordination during disasters in Vanuatu. Unfortunately, there was little evidence of strategic planning to ensure that health-care needs were adequately represented in wider planning for climate-related disaster response. This extended to a lack of strategic planning for HRH to meet current and future needs, and may reflect a wider lack of attention to the HRH strategy development process [43]. A good quality strong evidence base is needed for the development of adequate disaster response policies, plans and procedures to guide HRH response. Unfortunately despite a substantial amount of publicly available international literature relating to emergency response planning, the validity and generalizability of these to the Pacific context remains unclear [44].

4.3.5 Health-Care Capacity, Skills and Competencies

The capacity of the health system and its workforce to effectively respond to disasters will be influenced by the magnitude and impact of the disaster as well as the characteristics of the affected system and the availability of adequate resources to respond to needs [10]. Human resources management is essential to any health-care system. The size, composition and distribution of the health-care workforce to meet a particular country's present and future needs are essential for consideration in the climate driven disaster context [45]. An agile workforce with highly specialized skills is required to mount an immediate and effective response to disasters and humanitarian emergencies [11-14]. Here we describe the human re- sources capacity, skills, competency, development and training for disaster response in the case study countries.

4.3.6 Human Resources for Health Capacity

Climate-driven disasters place added stresses on health-care systems, and where these systems are already understaffed and overstretched, disease burden and health-care needs arising from disasters can exceed HRH response capacity [13,46]. Both Australian and international organizations and PIC respondents have acknowledged that PICs can be easily stretched beyond their HRH capacity in times of disasters, requiring external assistance for surge capacity. One Australian representative alluded to the fact that some countries do not have the capacity to conduct field triage or set up isolation wards, and NGOs often lack a clinical expertise. This is an area where military capabilities are often relied on [47]. However coordination challenges between military, civil society and NGOs can constrain the effectiveness of medical response [47]. The New Zealand Aid Programme also has capacity for HRH support from New Zealand; however offshore field medical care and search capacity was reportedly limited.

There was evidence of collaboration and partnerships with NGOs, community-based organizations and donor organizations to improve HRH capacity for emergency response. Both the WHO and UNICEF regional offices in Fiji reported that Red Cross Society Volunteers and Village Health Workers improve capacity to respond to health emergencies. For example, the Cook Islands Ministry of Health partnered with WHO, Red Cross and communities to respond to a dengue fever outbreak. In other situations, HRH capacity was reportedly managed through intra-island rotation (rural to urban and vice versa). Collaborations and partnerships provide a supportive environment to build adaptive capacity of the health sector and may be an indication that climate change is becoming the impetus to unite organizations and sectors around policy making to address HRH needs of PICs [48]. Other lessons were learned from the Samoan response to the Avianic flu response, where strategic health management resulted in the use of multidisciplinary health teams to mount a rapid and effective response [49]. According to one respondent:

> "We had swine flu before the tsunami so we trained unemployed youth as health assistants in villages so that they can help on the district hospitals during disaster events. The idea was about how these youth can help out in the district hospitals before the formal help arrives (e.g., wound dressing). This training helped when the tsunami hit; we're trying to apply this approach to up-skill in psychological training. Multi-skilling communities to help themselves partly address the shortage of nurses and medical practitioners in Samoa" (OUM, Samoa).

Health-care workers in both Fiji and the Cook Islands indicated their willingness to respond to their country's needs since they have a better understanding of local policies and cultural issues, than external counterparts. There were some levels of hesitancy in requesting health workers from overseas, with some respondents suggesting this as a last resort because "if they [overseas health workers] come in they have to learn the guidelines and policies of the facility very quickly to be able to work in it" (MOH-WestDiv, Fiji). The general feeling across PIC health-care interviewees was that despite their limited HRH capacity, the lack of physical resources for emergency response was even more critical. According to some respondents, the limited workforce can efficiently manage available resources for greater effectiveness. Limited finances, emergency medications and other disaster supplies were identified as additional challenges which affected emergency response, especially to outer islands and remote areas.

> "Without funding we can send 8 or 9 [persons] but no medication, because we can charter a flight. With more funding we can take more staff and medicines" (MOH, CI).

The literature indicates that strong health-care systems require significant resources and high levels of preparedness to improve health sector performance and out- comes in disasters [50]. The limited resource capacity in PICs has resulted in heavy reliance on donor funding and bilateral programs. While there is much funding available in the region for climate change and disaster risk reduction programs, very little of this is being channeled into climate change-related health programs and the development of the workforce capacity for disaster response. This has further implications for the management of the limited workforce and their effectiveness in disaster response. The limited focus and allocation of climate-related funding to health in the Pacific reflects the wider approach to global health delivery, where some of the very large donors such as the Gates Foundation or the Global Fund, consider climate change mitigation efforts as a government responsibility and not a part of their core business [48]. Given that limited HRH capacity is a reality in all four PICs, it is unlikely that donor-dependence will change in the immediate future. However, the sustainability of donor support requires assessment in light of global economic recession and emerging competing and other public health priorities in donor countries [51].

4.3.7 Human Resources for Health Skills and Competencies

Effective disaster response require a combination of the right people with appropriate training, being in the right place at the right time, with sufficient emergency re- sources [50]. In an ideal situation, the health sector should seek to maximize the functions of the health workforce, retain an efficient mix of staff and skill to improve service which can be applied in disaster response [52]. Disaster situations often require that the focus be changed from routine behaviours to those suited to disaster scenario.

Nursing staff, in all PICs, were actively involved in disaster response, based on their pre-existing roles. The general feeling was that nurses are expected to play a key role in post-disaster leadership and early assessment, providing information to various organizations. The disaster assessments responsibility is delegated to nurses in their capacity as civil servants and often the focal person in health facilities in remote areas. However, while carrying out their responsibilities, their confidence, skills and expertise in this area are often not acknowledged at the planning and management level. Recognition of the vast local knowledge and experience of the health workforce could be an asset to the wider disaster management process, in helping to understand the priority needs of affected communities. Recognition and adequate training of the health workforce would lead to adequate preparation, skills and competencies for effective disaster response [52]. According to one nurse leader in Fiji, "hospital-based nurses in urban areas need to be orientated to disaster management before going to the outer islands, and training should be arranged regularly to facilitate this". The need for training based on evidence has been highlighted by the disaster response sector [10].

The limited technical capacity to handle the immediate psychosocial needs post disaster was identified in all PICs, and affected the community, health-care workers and other response personnel. This resulted in heavy reliance on NGOs and the church community to address psychosocial needs. There was agreement across the health sector in all countries that in-country mental health capacity was severely lacking even in normal times. Early psychosocial interventions are required following disasters, especially those resulting in extreme/ widespread property damage, trauma and loss of life, and interruptions to livelihood [53]. This is particularly critical in developing settings, where existing HRH shortages, issues affecting social determinants of mental health and wellbeing may be exacerbated by disaster impacts [53,54]. Inter-agency cooperation and

coordination are important to ensure appropriate HRH is sourced to provide culturally appropriate mental health response [13,54].

Critical shortages of paramedical staff for field triage were also reported. These critical shortages of technical expertise for emergency response in PICs were reportedly, at times, filled by international HRH. Regardless of the HRH challenges, the research found evidence of high levels of commitment, multitasking and flexibility among health workers involved in disaster response.

> "Within the MOH the only directive I received was (to) 'manage your officers that they are at work,' ... based on our policies we looked to see who can be discharged home; we tried to minimize the people who were within the facility. Because we were stretched, we went onto 12-hour shifts... we would call the nurse and say 'prepare for a 12-hour shift, bring some extra pants and extra water'. It might sound militant but it helps" (MOH-WestDiv Fiji).

There was evidence of resilience developed through respondents' belief in their ability to cope and adapt to climate influences on disasters [24,55]. The long-term impact of the chronic shortage of HRH, especially if there are more frequent and / or severe disaster impacts, may eventually undermine this resilience as a result of limited staff being stretched beyond their capacity and their inability to maintain competencies and skills. The reliance on overseas support for technical expertise areas such as field triaging and mental health is not sustainable and requires urgent attention. There is therefore need for further assessment of how the workforce capacity can be improved in terms of the numbers, skills and competencies for improved disaster response, in light of uncertainties surrounding future pattern of disasters.

4.3.8 Human Resources for Health Training and Workforce Development

A properly trained and competent workforce that is aware of and prepared to meet present and future needs is essential for a successful healthcare system [45]. The availability of a workforce with specialized skills for disaster response requires adequate training institutions and programs where these skills can be developed and updated [18].

Interviews revealed training institutions for nursing personnel in all three of the four countries; however doctors from across the region were mainly trained in Fiji, with a small cadre being trained in Samoa. Respondents in Fiji

and Vanuatu indicated that disaster response was included in their nursing curriculum. Others reported efforts to ensure some level of in-service disaster training including desktop simulations, field simulations or training programs at the country level; including participation in multi-stakeholder field simulations from time to time. Across the four countries, HRH were interested in accessing disaster-specific training. However, one of the challenges to accessing training in the Pacific was the impact of small workforce. One donor indicated that since some organizations only had a few staff, this made it difficult to send people away for training, "[b]ut the Governments are committed towards training them" (WHO, Fiji). On the other hand, the challenge was reportedly to ensure that the right individuals were selected to participate in available training. Senior staff were reportedly more likely to be selected for training, but knowledge was not necessarily transferred to front- line or field staff. Samoan respondents indicated that triage and emergency medical care training should be disaster-specific. Disaster response training, including scenario planning is essential to building resilience [24].

Other challenges included the need for training in child psychology and post-trauma counselling in all countries. Additionally, "the limited numbers of students enrolled into medical and nursing training programs were insufficient to meet the current demands of the country" (OUM, Samoa); which underscored wider HRH recruitment issues across the region [56].

The issues with training and workforce development for disaster response are reflective of the wider HRH training issues such as low enrolments, shortage of workers, limited succession planning and access to appropriate courses, which are evident across the Pacific region [56]. These limitations can undermine the adaptive capacity of the health workforce for future response, since they affect recruitment, retention and stability of the workforce [57], and long-term resilience [24]. The importance of matching and forecasting the needs, demand and supply of HRH and the provision of training to build resilience and meet the health system needs of individual countries cannot be overemphasized [58]. While examples of adaptiveness including the upgrading and multi-skilling of nurses to address the shortfall in nursing and medical personnel have been reported, this was not representative across countries. There was room for exploring alternative and traditional mechanisms. Health workforce training and development may therefore be one of the most vulnerable aspects of the health-care capacity in PICs, and should be prioritized by national health sectors and donors with a view to building adaptive capacity for disaster response in the context of climate change and future uncertainty.

4.4 CONCLUSION

There is a growing body of evidence that the impacts of climate change are affecting population health negatively, including those in the Pacific region. Hence, an appropriately trained, qualified and agile health workforce is required to improve response to disasters. This is the first paper that looks specifically at the adaptive capacity of the health sector to disaster response in the climate change context in Pacific Island Countries. The research found several elements that are likely to support or constrain the adaptive capacity of the health-care sector to effectively respond to disasters, in the face of uncertainties presented by climate change.

Elements serving to strengthen the adaptive capacity of the individual country health-care sectors were: wide- spread involvement of the health sector in disaster response; health workforce beliefs in their own abilities and commitment to respond to their country's needs even in the face of limited resources; strong support from the NGO and donor community within the region, with Australia and New Zealand providing technical expertise and resources where these were lacking in respective countries.

Elements serving to constrain adaptive capacity included: variable and complex coordination and registration of international health workforce for disaster response; inadequate policies to coordinate HRH for disaster response in some countries and to address the welfare of staff and workers compensation during and following disasters; limited HRH capacity even in times of 'normality' means that staff are stretched beyond their capacity; chronic lack of resources and effective health-care provision; severe short- ages of technical expertise to meet psychosocial needs of the population, HRH and response personnel across all countries; inadequate skills and competencies in field triage and medical care; limited capacity for training of health workforce specialists in PICs.

This study reveals evidence of resilient elements of HRH in PICs. However several areas of vulnerability need to be addressed through the development of national HRH policies, strategic plans for disaster response, and a coordinated and collaborative approach for disaster response training which may be applicable to other areas across the Pacific Region.

Further research is recommended:

- The specific training needs of the health workforce to respond in times of disaster given the acknowledgement they work with limited human and material resources.

- The disaster assessment processes. Currently nurses using their local knowledge are first assessors; however, this is followed by numerous other assessments resulting in duplication, a lack of acknowledgement and information sharing.
- How the workforce capacity can be improved in terms of the numbers, skills and competencies for improved disaster response, in light of uncertainties surrounding future pattern of disasters.

REFERENCES

1. Bowen KJ, Friel S, Ebi K, Butler CD, Miller F, McMichael AJ: Governing for a Healthy Population: towards an understanding of how decision-making will determine our global health in a changing climate. Int J Environ Res Public Health 2011, 9:55–72.
2. Jones L, Jaspars S, Panvanello S, Slater R, Arnall A, Grist N, Mtisi S: Responding to a changing climate: Exploring how disaster risk reduction, social protection and livelihoods approaches promote features of adaptive capacity. London: Overseas Development Institute; 2010.
3. World Bank: World Development Report 2010: Development and Climate Change. World Bank: Washington, DC; 2010.
4. Coumou D, Rahmstorf S: A decade of weather extremes. Nat Clim Chang 2012, 2:491–496.
5. Knutson TR, McBride JL, Chan J, Emanuel K, Holland G, Landsea C, Held I, Kossin JP, Srivastava A, Sugi M: Tropical cyclones and climate change. Nat Geosci 2010, 3:157–163.
6. WHO/SEARO: Climate Change and Human Health in Asia and the Pacific: From Evidence to Action: Report of the Regional Workshop. Bali, Indonesia: WHO; 2007.
7. United Nations Development Programme: Climate change threatens human security in the Pacific Islands, top panel warns. Cairns: UNDP; 2009.
8. Asia Pacific Emergency Disaster Nursing Network: System-wide Quality Improvement: The Foundation of Emergency and Disaster Resilience. Auckland: APEDNN; 2010.
9. Bar-Dayan CY: International collaboration in disaster medicine–it is time for the "Big step" in disaster preparedness. Prehospital Disast Med 2008, 23:280–281.
10. Thompson L, Zwi A, Adogu C, Ranasinghe T, Martins J, Roberts G: Public health emergencies in the Asia-Pacific Region: Actors and institutions; coordination and management. Volume December 2011. Human Resources for Health Knowledge Hub: Sydney; 2011.
11. Maclellan N: Turning the tide: improving access to climate financing in the Pacific Islands. Lowy Institute for International Policy: Sydney; 2011.
12. Tangi T: Disaster Risk Management in the Pacific. Suva, Fiji Islands: SOPAC; 2009:17. 13. Urbano M, Maclellan N, Ruff T, Blashki G: Climate change and children in the Pacific islands – April 2010. UNICEF Pacific: Suva, Fiji; 2010.
14. WHO/SEARO: Regional Framework for action to protect human health from effects of climate change in the South East Asia and Pacific Region. Bali, Indonesia: WHO; 2007.
15. Brooks N, Adger WN: Assessing and enhancing adaptive capacity. Cambridge: Cambridge University Press; 2005.

16. Lim B, Spanger-Siegfried E, Burton I, Malone E, Huq S: Adaptation policy frameworks for climate change: developing strategies, policies, and measures. Cambridge: Cambridge University Press; 2005.
17. IPCC: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2001.
18. World Health Organization: The World Health Report 2006. Working together for health. Geneva: WHO; 2006.
19. WHO/WPRO: Human resources for health action framework for the Western Pacific Region: 2011-2015. Manila, Philippines: WHO Regional Office for the Western Pacific Region; 2011.
20. Gero A, Fletcher S, Rumsey M, Thiessen J, Kuruppu N, Buchan J, Daly J, Willetts J: Understanding the Pacific's adaptive capacity to emergencies in the context of climate change. Final Report. National Climate Change Adaptation Research Facility: Gold Coast, Australia; 2013.
21. Walker B, Holling CS, Carpenter SR, Kinzig A: Resilience, adaptability and transformability in social–ecological systems. Ecology Soc 2004, 9:5.
22. Biermann F: 'Earth system governance' as a crosscutting theme of global change research. Global Environ Change 2007, 17:326–337.
23. Ekström M, Kuruppu N, Wilby RL, Fowler HJ, Chiew FH, Dessai S, Young WJ: Examination of climate risk using a modified uncertainty matrix framework–Applications in the water sector. Global Environ Change 2013, 23:115–129.
24. McManus S, Seville E, Brunsdon D, Vargo J: Resilience Management: A Framework for Assessing and Improving the Resilience of Organisations. Resilient Organisations: Auckland; 2007.
25. Strengers Y: Conceptualising everyday practices: composition, reproduction and change, Working Paper No. 6. Carbon Neutral Communities: Melbourne; 2010.
26. McManus S, Seville E, Vargo J, Brunsdon D: Facilitated process for improving organizational resilience. Natural Hazards Review 2008, 9:81–90.
27. Food and Agricultural Organization (FAO): Disaster risk management system analysis: a guide book. Rome: FAO; 2008.
28. Kelman I, West JJ: Climate change and small island developing states: a critical review. Ecolog Environ Anthropol 2009, 5:1–16.
29. Kuruppu N, Liverman D: Mental preparation for climate adaptation: the role of cognition and culture in enhancing adaptive capacity of water management in Kiribati. Global Environ Change 2011, 21:657–669.
30. United Nations Development Program: Sustainability and equity, a better future for all. Human Development Report 2011. UNDP: Cairns; 2011.
31. Atkinson R, Flint J: Accessing hidden and hard-to-reach populations: Snowball research strategies. Social Res Update 2001, 33:1–4.
32. Rice PL, Ezzy D: Qualitative research methods: A health focus. Melbourne: Oxford University Press; 1999.
33. Charmaz K: 'Discovering'chronic illness: Using grounded theory. Soc Sci Med 1990, 30:1161–1172.
34. Hansen EC: Successful Qualitative Health Research: A Practical Introduction. St Leonard's: Allen & Unwin; 2006.

35. McMichael AJ, Campbell-Lendrum DH, Corvalán CF, Ebi KL, Githeko AK, Scheraga JD, Woodward A: Climate change and human health: risks and responses. Geneva: WHO Library; 2003.
36. Kaplan AD, Dominis S, Palen JG, Quain EE: Human resource governance: what does governance mean for the health workforce in low-and middle-income countries? Hum Resour Health 2013, 11:6.
37. Bremer R: Policy development in disaster preparedness and management: lessons learned from the January 2001 earthquake in Gujarat, India. Prehospital Disast Med 2003, 18:372–384.
38. International Federation of Red Cross and Red Crescent Societies: Cook Islands International Disaster Response Law Study Report. Geneva: IFRC; 2012.
39. Nelson CD, Beckjord EB, Dausey DJ, Chan E, Lotstein D, Lurie N: How can we strengthen the evidence base in public health preparedness? Disaster Med Public Health Prep 2008, 2:247.
40. Griffiths K: The Pacific Humanitarian Team (PHT): performance review 2008- 2012. UNOCHA: Suva, Fiji; 2013.
41. Aitken P, Leggat P, Robertson A, Harley H, Speare R, Leclercq M: Human resources issues and Australian Disaster Medical Assistance Teams: results of a national survey of team members. Emerg Health Threats J 2012, 5:18147.
42. Robertson AG, Dwyer DE, Leclercq MG: Operation South East Asia Tsunami Assist: an Australian team in the Maldives. Med J Aust 2005, 182:340–342.
43. Dussault G, Franceschini M: Not enough there, too many here: understanding geographical imbalances in the distribution of the health workforce. Hum Resour Health 2006, 4:12.
44. Challen K, Lee AC, Booth A, Gardois P, Woods HB, Goodacre SW: Where is the evidence for emergency planning: a scoping review. BMC Public Health 2012, 12:542.
45. Kabene SM, Orchard C, Howard JM, Soriano MA, Leduc R: The importance of human resources management in health care: a global context. Hum Resour Health 2006, 4:1–17.
46. International Federation of Red Cross and Red Crescent Societies: Legal preparedness for international disaster response in Australia: Laws, Policies, Planning and Practices. Geneva: IFRC; 2010.
47. Greet N: ADF experience on humanitarian operations: a new idea? Security Challenges 2008, 4:45–61.
48. Anstey MH: Climate change and health–what's the problem? Glob Health 2013, 9:4.
49. Buchan J, Connell J, Rumsey M: Recruiting and retaining health workers in remote areas: Pacific Island case-studies. Geneva: WHO; 2011.
50. Bissell RA, Pinet L, Nelson M, Levy M: Evidence of the effectiveness of health sector preparedness in disaster response: the example of four earthquakes. Fam Community Health 2004, 27:193–203.
51. Hanvoravongchai P, Adisasmito W, Chau PN, Conseil A, de Sa J, Krumkamp R, Mounier-Jack S, Phommasack B, Putthasri W, Shih C-S: Pandemic influenza preparedness and health systems challenges in Asia: results from rapid analyses in 6 Asian countries. BMC Public Health 2010, 10:322.
52. Mowafi H, Nowak K, Hein K: Facing the challenges in human resources for humanitarian health. Prehospital Disast Med 2007, 22:351–359.
53. Norris FH, Friedman MJ, Watson PJ: 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. Psychiatry: Interpers Biolog Process 2002, 65:240–260.

54. Davidson J, McFarlane AC: The extent and impact of mental health problems after disaster. J Clin Psychiatry 2006, 67(Suppl 2):9–14.
55. Gillespie BM, Chaboyer W, Wallis M, Grimbeek P: Resilience in the operating room: developing and testing of a resilience model. J Adv Nurs 2007, 59:427–438.
56. Doyle J, Asante A, Roberts G: Human Resources for Health: Issues and challenges in 13 Pacific Island Countries (2011). Human Resources for Health Knowledge Hub: Sydney; 2011.
57. Buchan J: Reviewing the benefits of health workforce stability. Hum Resour Health 2010, 8:29.
58. Dussault G, Buchan J, Sermeus W, Padaiga Z: Assessing future health workforce needs. Geneva: WHO; 2010.

CHAPTER 5

The State of Healthcare Disaster Plans in New Zealand and the Sultanate of Oman: An International Comparative Analysis

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5.1 INTRODUCTION

Disasters are unique situations that require advanced planning in order to anticipate their effects and develop countermeasures to mitigate hazards, reduce risks, respond to emergencies, and recover from such events [1]. Disasters are situations of chaos and the quicker the situation is brought under control the better the outcome will be [2]. In contrast, failure to institute control due to weak planning leads to protracted chaos and worse outcomes [3]. Effective planning reduces guesswork during a disaster response. The success and failure of a disaster response are determined by the level of planning of the affected community.

Disaster planning is a systematic process that has four main components: identifying hazards, mitigating risks, preparing and responding to emergencies, and, finally, recovery and development [3]. All components of the planning process have to be documented and recorded for evaluation and future reference.

Documentation of the disaster planning process leads to the formulation of disaster plans. Moore defined disaster plans as follows:

> "A formal document that (1) assigns roles and responsibilities to individuals and organizations for carrying specific tasks during an emergency; (2) clarifies lines of authority and organizational responsibilities, including how tasks will be coordinated; (3) describes how people and property will be protected; (4) identifies personnel, supplies, facilities and other resources available within or to a jurisdiction during response and recovery activities and (5) identifies steps to improve mitigation during response and recovery operations" [4].

Healthcare providers in New Zealand and the Sultanate of Oman are required by national regulations to develop and maintain health preparedness plans. These plans are to encompass the components of disaster planning such as the four Rs (reduction, readiness, response, and recovery) phases [5]. The plans in New Zealand have to meet the Health and Disability Standards (2008) and the plans must reflect the overall national emergency management system [5]. In Oman, the National Committee for Civil Defense is currently developing the first national standards for regional health emergency plans. Disasters covered by healthcare plans are variable and include internal and external potential risks. Internal risks include situations in which the internal structure of the healthcare system is the cause for the disaster such as a collapse of a hospital, failure of power supply, or a staff strike. External risks include earthquakes, tsunamis, and wars. The current healthcare plans from New Zealand and Oman have not been subjected to evaluation.

This study aims to audit the coverage of disaster plans in terms of describing and addressing the main components of the disaster planning process. It is important to appreciate that the goal of such an evaluation is not to show the deficits of emergency plans in both countries; rather it aims to find areas for improvement. Comparative analysis of disaster preparedness across countries shows how healthcare systems adapt to local circumstances and emphasizes the importance of emergency planning internationally.

5.2 METHODS

The study consisted of all the responsible authorities in New Zealand (21 DHBs) and Oman (13 hospitals).

The assessment framework was adapted from international emergency plan checklists. The checklists included the World Health Organization Hospital Emergency Response Checklist; the Mass Casualty Disaster Plan Checklist from the Centre for the Study of Bioterrorism and Emerging Infections; and the United States Joint Commission on Accreditation of Healthcare Organizations (JCAHO) Standards for Emergency Management [6–8]. These checklists have been extensively used to audit emergency plans worldwide. The checklist used in this project included twelve generic domains of strategic emergency preparedness which are command and control, hazard analysis, resources and surge capability, communication and logistics, emergency response standard operating procedures (SOPs), life-line backups, public and media, training, security, welfare, coordination, and recovery. Each one of these domains has several specifics. The full checklist has 60 different specifics. The checklist was assessed by five emergency planning experts in New Zealand and Oman for relevance and comprehensiveness.

New Zealand DHB-level current and up-to-date strategic emergency preparedness plans were obtained by contacting all emergency planners in 2009. Fourteen (66.7%) of the 21 DHBs, at the time, provided hard or electronic copies of their plans. A further public domain search using internet and personal contacts failed to obtain any further plans from nonresponding DHBs.

Similarly, emergency plans of all secondary and tertiary hospitals in Oman were collected in 2009. Primary hospitals were excluded as strategic emergency planning usually occurs at secondary and tertiary level facilities. Seven hospitals (53.8%) provided written emergency plans out of possible 13 hospitals in Oman. An internet search and personal contact with clinicians did not locate any further plans.

In this study a deductive approach was utilized given that the aim of the study was to assess the existence of critical elements of emergency preparedness as described by the overall framework of written emergency plans [3].

A content analysis process was used firstly to ascertain the coverage of emergency preparedness elements within plans and secondly to score them according to whether or not they had addressed the specifics of the 12 domains. A value of "one" was given if the specific existed and is described in the plan and "zero" if the specific is not described. The aggregate score was calculated for each plan in all the 12 domains. The national score in each domain is the aggregate of individual plans divided by the number of plans analyzed in each country. All plans were independently scored by the primary researcher and a research assistant. Where disagreement arose on the score, agreement was reached by

further review and discussion. A similar method has been used to evaluate the completeness of influenza preparedness plans in Europe [9]. The study did not evaluate the exact quality of the written plans because there are currently no validated systematic scoring systems for quality assessment of written emergency plans.

The results are presented as an average national score of the plans in each of the 12 domains. A percentage of coverage in each of the twelve areas of emergency preparedness between New Zealand and Oman was also calculated from simple division of mean score by the maximum points in each domain.

The Statistical Package for Social Sciences (SPSS) software (SPSS Statistics 12.1, for Windows, New York) will be utilized in the data analysis. In order to assess the significance of differences in the variables, a series of Chi-Square tests and the Fisher exact tests will be used where appropriate. The study has been approved by the New Zealand Multiregion Ethics Committee and the Omani Ministry of Health.

5.3 RESULTS

There were 14 plans from New Zealand included in this analysis out of the 21 DHBs (66.7%). There were 1056 pages of New Zealand emergency planning material reviewed. In Oman there were seven plans out of a potential 13 plans from the secondary and tertiary hospitals (53.8%). There were 677 pages of Omani emergency planning material reviewed.

Figure 5.1 shows the percentage of the national mean scores (±standard deviation) of New Zealand and Omani emergency preparedness plans in 12 strategic emergency preparedness areas. The overall national mean score of the coverage of New Zealand plans was 40.5 (±6.3) and the percentage was 67.5% of the maximum possible score (i.e., 60). On the other hand, the Omani overall mean score for coverage of emergency preparedness elements was 32.3 (±4.1), which is 53.3%. Plans from both countries were similar in addressing the "command and control" domain of emergency response (73.8% for New Zealand versus 71.3% for Oman). Alternative arrangements for command and control, such as situations where the command post is destroyed in an emergency, are the least described specific in this domain.

Plans in both countries scored 62% in the hazard analysis category. However, there was little emphasis on internal hazards such as industrial action by staff strike, disease outbreak in the hospital, and electricity failure. Fire hazard was

the only internal hazard that was frequently addressed by plans in New Zealand and Oman. Furthermore, there was no plan that addressed the concept of syndromic surveillance of patient flow and presentations. This concept means continuous monitoring of patient presentations to healthcare services in order to identify clusters of patients that could indicate an early wave of a pandemic [10]. The plans otherwise scored well for external hazard analysis.

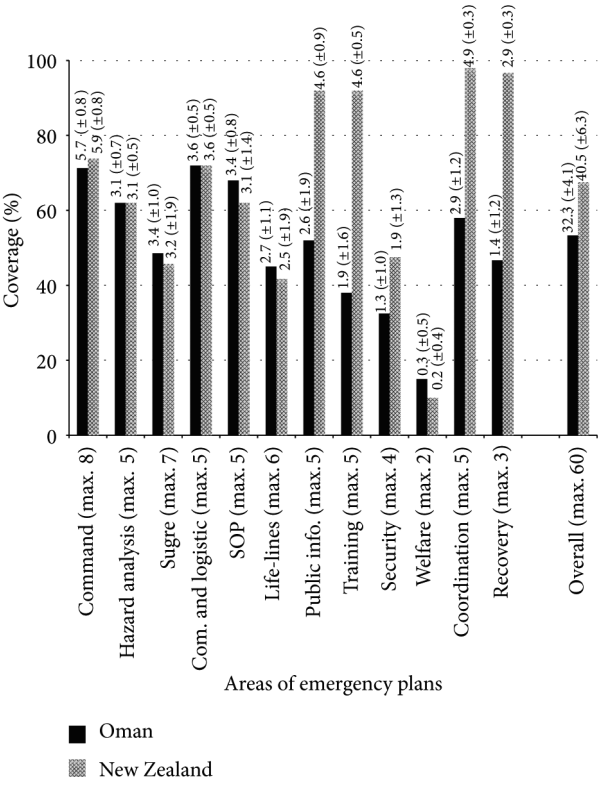

FIGURE 5.1 Percentage of coverage of emergency preparedness elements in written plans in New Zealand and Oman.

The plans in both countries scored less than 50% of the maximum score for surge capability and resource management (New Zealand: 45.7%, Oman: 48.6%). Only a few plans appreciated the value of keeping an updated record of available resources that can be utilised during a mass emergency response. Almost all plans failed to describe a process of enhancing surge capability during

a mass emergency event. The majority of plans used generic and vague comments such as "request resources from the Ministry of Health."

In terms of communication and logistics, plans from both countries scored equally at 72% of the maximum score. Areas such as establishing a cascade of communication when calling extra healthcare providers are not addressed. Furthermore, emergency plans relying heavily on telephone communications and backup systems such as "runners" were not described.

Omani plans scored an average of 68% of the maximum score in stating their standard operating procedures (SOPs) compared to New Zealand plans, which scored 62%. There is a potential for improvement in terms of setting broad guidelines about SOPs such as patient flow, patient tracking systems, and entry and egress to emergency departments. Decontamination of victims prior to definitive healthcare appeared to be an issue that plans underappreciated in both countries.

Emergency plans in New Zealand and Oman scored 41.7% and 45% of the maximum score, respectively, in addressing the issue of life-line utilities such as water, food, shelter, sanitation, and power during a mass emergency response. Few plans explicitly discussed how to utilize volunteers and deal with donation of goods and services.

The Omani plans reviewed in this analysis scored significantly lower than their New Zealand counterpart plans in terms of describing a process for dealing with the public and the media during a mass emergency response (52% versus 92%).

The modalities of staff training used and their frequency of occurrence were explicitly addressed in New Zealand plans compared to plans from Oman (92% versus 38%). However, the issue of welfare of staff during and after a mass emergency response received little attention in both countries with plans scoring 15% and 10% in Oman and New Zealand, respectively. Moreover, security issues and process for healthcare facility lockdown scored 32.5% and 47.5% in the Omani and New Zealand plans.

Coordination and collaboration were comprehensively discussed in New Zealand emergency preparedness plans with an aggregate score of 98%. On the other hand, the Omani plans superficially touched on the issue of coordination and collaboration with other agencies during a mass emergency response with an aggregate coverage score of 58%.

Finally, the recovery phase of emergency response was included in almost all New Zealand emergency plans with an aggregate completeness score of 96.7% compared to 46.7% in the Omani plans in which the recovery phase did not feature to a significant extent.

5.4 DISCUSSION

The overall national mean scores of 40.5 and 32.5% of the maximum in New Zealand and Oman mean that there is room for improvement.

The lowest scoring plan was that in ensuring the welfare of staff and first responders, where the scores were around 30–40% of the maximum. Responding to a disaster is a mentally and physically demanding task for many acute care providers [11]. In New Zealand employees are protected by the Health and Safety Employment Act 1992 in which "employers are required to actively take practical steps to mitigate risk and protect employees" [12]. It is important to appreciate that emergency responders are particularly at risk of postresponse psychological and physical complaints [11]. Identification and control of occupational hazards are essential, and can be simply achieved by providing PPE to responders. Preevent planning should take this into account, and the presence of psychological and physical ill-health should be detected during and after the event. It is an ethical reciprocal duty of the healthcare organization to ensure the welfare of responders and their families in order to maintain high level participation of responders [11]. International studies have found that for most emergency responders the wellbeing of themselves and their families is a priority that has to be addressed and should be explicitly reflected in emergency plans [13].

Security is another important domain that requires more attention in New Zealand and Omani strategic emergency planning. This is to ensure the safety of responders and victims alike. Proper security provides a working environment for responders to provide critical services without interference from the curious worried well people [14]. It is also essential to communicate to the public that such strict security measures are not to limit their rights to access public facilities but to ensure control of the medical response operations established. The importance of such measures became apparent at St Vincent's hospital in New York City during the September 11, 2001, terrorist attacks in which the worried well inundated the emergency department and hindered the overall medical response [15]. Therefore, strategic emergency planners in New Zealand and Oman could enhance security planning by adopting the lessons learned from international emergencies.

This study found that plans are only 50% complete when it comes to planning for ensuring essential services such as food, clean water, power, and sanitation measures during an emergency response. The World Health Organization initiated a project called "Safe Hospitals" in which functional failure, such as not maintaining clean water sources for victims and responders, is the most common

reason for hospital dysfunction during a disaster response [16]. It is very likely that the public supply of such essential resources will be disrupted and therefore hospitals and healthcare planners have to be vigilant and plan ahead for such possibilities by developing contingency plans to self-sustain for at least 72 hours until external help can be called in [17]. Lessons from New Zealand's Canterbury earthquakes showed the value of being prepared to sustain long-term outages of life-line utilities such as power and water [18]. During the event, extra generators maintained emergency healthcare services at Christchurch Hospital despite the outage of main power supplies. On the other hand, Cyclone Gonu is an Omani example in which failure to provide clean water and a sustained source of food for hospitals contributed to a dysfunctional healthcare response in some hospitals [19, 20]. For instance, Sur Hospital (a regional secondary hospital) had no clean water supply for days and healthcare staff faced a difficult time trying to source-clean water from local providers. Such examples highlight the need for preparedness of core life utilities.

The coverage of disaster healthcare plans in New Zealand and Oman for strategic emergency preparedness elements is variable. This may be a reflection of the local capability of DHBs and hospitals to conduct a proper emergency planning. The variability in emergency planning exists at a global level. An international survey by the World Health Organization of 60 countries around the world found that 89% of countries have health-specific emergency plans [21]. This observation was regionally variable; for instance, 40% of countries in the Pan-Americans Health Office to 78% in middle-eastern countries conduct strategic emergency planning [21].

Some of the between-countries differences may be due to the national health disaster plans developed in New Zealand. This is clearly evident under the "coordination and collaboration" domain in which plans in this study have 98% coverage and to a lesser degree under "command and control."

This study showed that there is a clear difference in recovery plans coverage between New Zealand and Oman (96.7% versus 46.7%). Mass emergencies do not end by the arrival of the last patient, but rather they tend to have a long lasting effect. Healthcare recovery plans tend to focus on returning healthcare services to their preevent state. The healthcare recovery tends to be narrow. In reality, recovery planning is a complex community-wide process to basically determine the future of the affected community [1].

This study found that disaster plans address "hazard analysis" adequately particularly the external natural and man-made hazards. More improvement could be achieved in terms of analyzing internal hazards such as staff strike,

hospital-based outbreaks, and fires. With financial pressure on many DHBs in New Zealand and many hospitals in Oman, staff strikes are becoming frequent and are a likely disruption to the provision of healthcare services [22–24].

The New Zealand health emergency plan delineated clearly how to coordinate and collaborate with other emergency responders such as the police, civil defence, and the military as well as how to institute a command and control structure based on the CIMS principles [5, 25]. This helps DHBs to establish networks and links with other governmental agencies that could play a role during a mass emergency response and promptly establish a chain of command. On the other hand, the lack of a national health-specific emergency framework in Oman appears to filter down to hospital level planning where plans differ significantly between hospitals and score relatively low on "coordination and collaboration." The results are consistent with published studies from other countries. Ciraulo and others surveyed hospitals in the United States and found that 26.3% did not address command and control issues in their emergency planning [26, 27]. Furthermore, a comprehensive survey by Mann and others found that 50% of the states in the USA have no indication of a structure for command and control in healthcare response [28]. However, such studies differ from the survey presented here in that they did not analyze individual plans; rather they surveyed chief executives and asked them about the issues covered or not covered in their institutions' plans.

National standards and guidelines for mass emergency planning, such as the New Zealand Health and Disability Standards (2008), are useful only if adhered to. The value of such strategic guidelines is clear in the high score of New Zealand plans in areas such as "training" and "public information and media." New Zealand DHBs are obliged to meet such standards when formulating an emergency plan. This study found that not all participating DHBs meet all the standards. It is also paramount for policy makers to provide an incentive for DHBs and hospitals to meet national standards. An example of such an approach is to tie emergency planning to an accreditation process. For instance, the Joint Commission for Accreditation of Health Organizations (JCAHO) in the United States provides clear emergency planning standards that have to be met in order to obtain accreditation points [28]. There is a similar system in New Zealand in which DHBs have to show completeness of plans in order to be funded for emergency planning. However, care must be entertained as such an approach might deter DHBs and hospitals from the planning process per se to focus on drafting a presentable plan for the sake of getting the funds.

5.5 STRENGTHS AND LIMITATIONS

This study has several strengths and limitations. First, it is the first attempt to systematically review and evaluate strategic healthcare emergency preparedness plans in New Zealand and Oman. Second, the emergency plans analyzed in this study are representative samples of plans in both countries. However, it is possible that nonresponding agencies might have different levels of planning and preparedness and therefore are less inclined to share their plans. If this is the case, the results presented here will overestimate the coverage and completeness of strategic emergency plans.

Third, emergency planning is a process and a moving target. Therefore, this study is only a snapshot in the 2009-2010 period and the plans analysed here might well have changed. There have been several events in both countries (e.g., Canterbury earthquakes and Cyclone Phet) that were catalysts for plan reviews. Hence, the areas for improvement addressed by this study might have already been incorporated in the current hospital preparedness plan in New Zealand and Oman. Multiple studies have reported this particular limitation of mass emergency preparedness surveys [26, 29].

Fourth, it is critical to appreciate that plans are only a written document and might not reflect the actual planning process well. Therefore, the coverage and completeness of plans are only an indicator for strategic healthcare emergency preparedness. The preparedness of hospitals to deal with mass emergencies, which can be enhanced by a robust plan, can also be influenced by multiple known and unknown factors such as the nature and circumstances of the mass emergency. The completeness and coverage of the plans could simply reflect the attention to drafting the written document rather than a real preparedness effort. A study by Mounier-Jack and Coker analyzed influenza pandemic plans from several European countries and speculated that a limitation in their study is that written plans can only be considered a proxy for actual planning [9]. Furthermore, in this study DHBs and hospitals might have other emergency plans that were not shared with the authors and that might have addressed operational emergency preparedness issues separately. Therefore, such plans would not factor in this analysis. In such cases, the results presented here would be an underestimate of the coverage of disaster plans. Nevertheless, emergency planners were requested to share all their plans.

Finally, even though the study utilizes objective checklists used widely in emergency preparedness, the scoring system can still be subjective and interpretive. Plans are open to interpretation and scoring is a subjective exercise.

However, having two researchers independently scoring the same plan helps to objectify the plan analysis. An associated limitation is that this study did not address the quality of the plans and, instead, focused on the existence of essential emergency preparedness elements in the current written plans in New Zealand and Oman.

5.6 CONCLUSION

This study offers a method for assessing emergency plans and provides baseline information that will be useful for ongoing planning efforts in New Zealand and Oman as well as for policy makers and researchers in other countries to compare performances with. The study highlighted the value of having a national health emergency plan in New Zealand as reflected by the high scores of DHB emergency plans in areas such as coordination and collaboration. Therefore, a similar approach in Oman will assist in conducting comprehensive strategic emergency preparedness planning. A national plan will also streamline relationships and networks with other emergency responders such as the civil defense and the police.

Responders' welfare is an issue that needs to be clearly addressed by strategic emergency preparedness plans in New Zealand and Oman. This study reiterated the concerns of emergency planners about the lack of current measures to look after their "own warriors," while security issues during mass emergency responses are yet to be explicitly covered by emergency plans in both countries. Private security companies have more experience and expertise in such issues than healthcare systems. Therefore, incorporation of the private sector in future studies of health system disaster planning could be important for addressing such issues. Recovery planning and surge capability are also areas that require further development and guidance in terms of strategic emergency preparedness planning in New Zealand and Oman. Disaster planning will continue to be a national priority for healthcare services in New Zealand and the Sultanate of Oman.

REFERENCES

1. R. W. Perry and M. K. Lindell, "Preparedness for emergency response: guidelines for the emergency planning process," Disasters, vol. 27, no. 4, pp. 336–350, 2003.
2. J. F. Waeckerle, "Disaster planning and response," The New England Journal of Medicine, vol. 324, no. 12, pp. 815–821, 1991.

3. P. M. Ginter, W. J. Duncan, and M. Abdolrasulnia, "Hospital strategic preparedness planning: the new imperative," Prehospital and Disaster Medicine, vol. 22, no. 6, pp. 529–536, 2007.
4. S. Moore, A. Mawji, A. Shiell, and T. Noseworthy, "Public health preparedness: a systems-level approach," Journal of Epidemiology & Community Health, vol. 61, no. 4, pp. 282–286, 2007.
5. National Health Emergency Plan, Wellington Ministry of Health, 2008.
6. "Hospital Emergency Response Checklist," World Health Organization, Copenhagen, Denmark, 2011.
7. Association for Professionals in Infection Control Epidemiology, Mass Casualty Disaster Plan Checklist: A Template for Healthcare Facilities, Association for Professionals in Infection Control Epidemiology, Center for the Study of Bioterrorism Emerging Infection, Washington, DC, USA, 2001.
8. "Revisions to emergency management standards approved for long term care," Joint Commission Perspectives, vol. 22, no. 6, pp. 5–6, 2002.
9. S. Mounier-Jack and R. J. Coker, "How prepared is Europe for pandemic influenza? Analysis of national plans," The Lancet, vol. 367, no. 9520, pp. 1405–1411, 2006.
10. K. J. Henning, "Overview of syndromic surveillance. What is syndromic surveillance," Morbidity Mortality Weekly Report, vol. 53, pp. 11–26, 2004.
11. D. A. Alexander and S. Klein, "First responders after disasters: a review of stress reactions, at-risk, vulnerability, and resilience factors," Prehospital and Disaster Medicine, vol. 24, no. 2, pp. 87–94, 2009.
12. Health and Safety Employement Act, 1992, http://www.osh.dol.govt.nz/law/hse.shtml.
13. W. B. Rudman, J. F. Metzl, and R. A. Clarke, Emergency Responders: Drastically Underfunded, Dangerously Unprepared: Report of an Independent Task Force, Council on Foreign Relations Press, New York, NY, USA, 2003.
14. D. Hogan and J. Burstein, Disaster Medicine, Lippincott Williams & Wilkins, Philadelphia, Pa, USA, 2007.
15. L. Kirschenbaum, A. Keene, P. O'Neill, R. Westfal, and M. E. Astiz, "The experience at St. Vincent's Hospital, Manhattan, on September 11, 2001: preparedness, response, and lessons learned," Critical Care Medicine, vol. 33, no. 1, pp. S48–S52, 2005.
16. "Safe Hospitals Project World Health Organization," 2011, http://www.safehospitals.info.
17. R. D. Zane, P. Biddinger, L. Ide et al., "Use of "shuttered" hospitals to expand surge capacity," Prehospital and Disaster Medicine, vol. 23, no. 2, pp. 121–127, 2008.
18. J. R. Stevenson, H. Kachali, Z. Whitman, E. Seville, J. Vargo, and T. Wilson, "Preliminary observations of the impacts the 22 February Christchurch earthquake had on organisations and the economy: a report from the field (22 February–22 March 2011)," Bulletin of the New Zealand Society for Earthquake Engineering, vol. 44, no. 2, pp. 290–298, 2011.
19. S. Al-Shaqsi, "Care or cry: three years from cyclone gonu. What have we learnt?" Oman Medical Journal, vol. 25, no. 3, pp. 162–167, 2010.
20. M. Y. Alhinai, "Tropical cyclone Gonu: number of patients and pattern of illnesses in the primary health centers in A'Seeb area, Muscat, Sultanate of Oman," Oman Medical Journal, vol. 26, no. 4, pp. 223–228, 2011.
21. Alwan, Global Assessment of National Health Sector Emergency Preparedness & Response., World Health Organization, Geneva, Switzerland, 2008.

22. T. L. Farrow and A. J. O'Brien, "Discourse analysis of newspaper coverage of the 2001/2002 Canterbury, New Zealand mental health nurses' strike," International Journal of Mental Health Nursing, vol. 14, no. 3, pp. 187–195, 2005.
23. J. Rietveld, "Strike action by senior medical staff in Timaru: how did this come about?" New Zealand Medical Journal, vol. 116, pp. 1170–1171, 2003.
24. G. Robinson, K. McCann, P. Freeman, and R. Beasley, "The New Zealand national junior doctors' strike: implications for the provision of acute hospital medical services," Clinical Medicine, vol. 8, no. 3, pp. 272–275, 2008.
25. The Ministry of Civil Defence and Emergency Management, "The New Zealand Coordinated Incident Management System (CIMS)," New Zealand Fire Service Commission, Wellington, New Zealand, 2006.
26. D. L. Ciraulo, E. R. Frykberg, D. V. Feliciano et al., "A survey assessment of the level of preparedness for domestic terrorism and mass casualty incidents among Eastern Association for the Surgery of Trauma members," The Journal of Trauma, vol. 56, no. 5, pp. 1033–1039, 2004.
27. W. Higgins, C. Wainright III, N. Lu, and R. Carrico, "Assessing hospital preparedness using an instrument based on the Mass Casualty Disaster Plan Checklist: results of a statewide survey," American Journal of Infection Control, vol. 32, no. 6, pp. 327–332, 2004.
28. N. C. Mann, E. MacKenzie, and C. Anderson, "Public health preparedness for mass-casualty events: a 2002 state-by-state assessment," Prehospital and Disaster Medicine, vol. 19, no. 3, pp. 245–255, 2004.
29. B. Adini, A. Goldberg, D. Laor, R. Cohen, R. Zadok, and Y. Bar-Dayan, "Assessing levels of hospital emergency preparedness," Prehospital and Disaster Medicine, vol. 21, no. 6, pp. 451–457, 2006.

PART III
Defining Effective Medical Responses to Disaster

CHAPTER 6

Orthopaedic Surgery in Natural Disaster and Conflict Settings: How Can Quality Care be Ensured?

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6.1 INTRODUCTION

Physical trauma is a leading cause of global mortality, with natural disasters and armed conflicts contributing significantly [1, 2]. As the latter most often occur in low- and middle-income countries (LMICs), it follows that these settings have the highest related trauma burden [3–6]. Many trauma cases require surgical intervention, particularly orthopaedic surgery. However, LMICs often lack the surgical capacity to meet these needs and thus there is a reliance on external actors. Médecins sans Frontières (MSF), an international, independent,

humanitarian medical organisation, provides medical assistance to vulnerable populations, including those affected by natural disasters and conflicts. Surgical care is an integral part of its work, and over the last 40 years, MSF has provided surgical care in natural disaster and conflict settings in more than 70 countries. Orthopaedic surgery (i.e. surgical treatment of injuries or disorders of the musculoskeletal system) constitutes a large part of this care.

To ensure quality surgical care, MSF has established a minimum set of context-specific standards that must be in place before any surgical procedures can be performed [7, 8]. This practice conforms to the Sphere guidelines on minimum standards in disaster response [9]. While such prerequisites can limit the possibilities of performing surgery, MSF has demonstrated that in many natural disaster and armed conflict settings it is possible to implement these minimum standards, even for more rigorous procedures like internal fixation.

The need for minimum standards to ensure delivery of quality care has been previously documented [10]. However, there are no studies to date reporting on whether it is possible to implement such standards for orthopaedic surgery (particularly more demanding procedures like internal fixation) in natural disaster and conflict settings and, when this is possible, the related outcomes.

Based on the MSF experience of performing orthopaedic surgical activities in natural disaster and conflict settings in Haiti, Afghanistan and the Democratic Republic of the Congo (DRC) we describe: (a) whether it has been possible to implement the minimum standards required for performing among the more rigorous orthopaedic procedures—internal fixation—and when possible, the approximate time frame, (b) the volume and type of orthopaedic activities performed and (c) the outcomes of these activities (intra-operative mortality rates and postoperative infection rates).

6.2 MATERIALS AND METHODS

6.2.1 Study Design

This was a descriptive study using routine MSF programme data.

6.2.2 Study Setting

The study was conducted in the surgical programmes of the MSF emergency intervention following the 2010 earthquake in Haiti (Cité Soleil, Chancerelles,

Sarthe) and in three ongoing MSF projects in Kunduz (Afghanistan), Masisi (DRC) and Tabarre (Haiti). Specific details about the surgical capacity and available resources at each site are shown in Table 7.1.

TABLE 6.1 Surgical capacity and available resources at the six study sites

	Cité Soleil	Chancerelles	Sarthe	Masisi	Kunduz
Operating rooms	3	2	1	2	2
Surgical beds	20	20	70	20	50
Level of intensive care[a]	1	–	–	–	2
Intensive care beds	3	–	–	–	4
Surgeons per shift for OT	2	2	1	1	2
Level of surgical skill[b]	Senior	Senior	Senior	Trainee	Junior
Orthopaedic surgeons per shift for OT	2	2	1	–	3
Level of orthopaedic surgical skill[b]	Senior	Senior	Senior	–	Junior
Nurses per shift/per 20 surgical beds	2	2	2	2	2
Level of surgical nursing skill	Junior	Junior	Senior	Trainee	Trainee
Hospital surgical infrastructure[c]	Good	Good	Excellent	Good	Good
Hospital surgical equipment and supply[c]	Good	Good	Excellent	Good	Excellent
Type of patients presenting for orthopaedic care	Mainly accidental trauma	Mainly accidental trauma	Mainly accidental trauma	Accidental and violent trauma	Accidental and violent trauma
Patient follow-up possible	No	No	No	No	Yes
Internal fixation	No	No	Yes	No	Yes

OT operating theatre

[a] Level of care (LOC) of 1 = continuous instrumental monitoring including noninvasive blood pressure, pulse oximetry and heart rate + clinical surveillance (respiratory rate, Glasgow score, urine output, temperature, etc.); LOC of 2 = LOC 1 + continuous ECG monitoring and noninvasive mechanical ventilation

[b] Based on a staged classification system of military surgeons [11]

[c] Based on MSF infrastructure and equipment checklists

6.2.2.1 Citŭsoleil, Chancerelles and Sarthe

On 12 January 2010, Port-au-Prince was devastated by an earthquake. More than 200,000 people were killed and some 300,000 people injured [12]. At the time of the earthquake, MSF Operational Centre Brussels (OCB) had been operational in Haiti since 1991 and as such it was able to launch a rapid and well-organised response. Surgical activities were a primary focus and were established in two existing Ministry of Health (MoH) structures (Cité Soleil and Chancerelles hospitals); meanwhile an old warehouse was converted into a hospital, and towards the end of February 2010 Sarthe hospital was opened exclusively for trauma care. All orthopaedic surgical activities were transferred to this facility.

6.2.2.2 Masisi

Masisi is an area of persistent conflict where MSF OCB, in collaboration with the MoH, has been supporting a General Referral Hospital in North Kivu province since September 2007. In addition to the provision of free general health care, MSF also provides basic surgical/orthopaedic care at this hospital.

6.2.2.3 Kunduz

Afghanistan has suffered years of ongoing conflict, and MSF OCB fills a gap in the provision of trauma care through the Kunduz Trauma Centre which was opened in August 2011 in the northeastern province of Kunduz.

6.2.2.4 Tabarre

A Surgical and Trauma Centre was built new in the Tabarre neighbourhood of Port-au-Prince, Haiti and provides specialised care for visceral surgery and trauma patients, including orthopaedic care. It was created to address the gap in trauma care left by the 2010 earthquake. Quality standards were prioritised from the onset including infrastructure, material and human resources (qualified staff that had worked with MSF before in Sarthe hospital were hired). All types of trauma cases are seen at the centre.

6.2.3 Orthopaedic Procedures

Orthopaedic interventions and their characteristics were classified according to a standardised system described previously [13]. At the time of the study, it was not possible to stabilise and treat any type of spinal fractures or provide prosthetic treatment for hip fractures, including open reduction and internal fixation.

6.2.4 Minimum Surgical Standard Requirements

In MSF there are seven basic prerequisites for surgical care:

1. Adequate infrastructure, including protection from the external environment and appropriate electricity and lighting
2. Adequate water and sanitation provisions, waste management being a key priority
3. Availability of all essential disposables, drugs and equipment
4. Strict adherence to hygiene requirements and universal precautions
5. Mandatory use of sterile equipment for surgical and anaesthesia procedures
6. Capability for blood transfusion
7. Adequate human resources in quantity and quality

These requirements are stepped up if internal fixation procedures are performed, due to the inherent risks and complications (e.g. osteomyelitis), including frequent assessment and supervision:

- Improved air quality with filters
- Availability of water supply in quantity and quality
- Special orthopaedic accessory table, C-arm and single-use gowns and drapes
- Reinforced dress code and flows, use of hydroalcoholic solutions and surface disinfectants
- Clearly defined clean and dirty circuits in sterilisation, autoclave (minimum 90 l) and instrument disinfectants
- Qualified orthopaedic surgeons, nurses and infection control officers, physiotherapy specialists
- Availability of antibiotic culture and sensitivity

6.2.5 Inclusion/Exclusion Criteria

Surgical interventions described in this study were limited to orthopaedic procedures and excluded any isolated soft tissue surgery not requiring specific orthopaedic instruments.

6.2.6 Study Period

Data on the orthopaedic surgical activities performed at the different study sites for the following periods were included: Cité Soleil (16 January to 25 February 2010); Chancerelles (20 January to 25 February 2010); Sarthe (26 February 2010 to 6 June 2011); Masisi (3 September 2007 to 30 June 2014); Kunduz (30 August 2011 to 30 June 2014); and Tabarre (13 February 2012 to 30 June 2014).

6.2.7 Data Collection and Analysis

Data on all surgical/orthopaedic procedures performed in MSF programmes are routinely entered into a standardised logbook and transcribed into an electronic database (Microsoft Excel). Data for this study were sourced from this database. These data were aggregated at MSF OCB headquarters, reviewed for completeness and accuracy and validated by cross-checking with data held in individual patient records.

The data variables included: number of patients, number of surgical and orthopaedic procedures, type and number of orthopaedic procedures, intra-operative deaths and overall postoperative infection rate.

Intra-operative mortality was defined as any death occurring during the induction of anaesthesia, the intervention itself or the immediate recovery period. A postoperative infection was defined as any surgery-related infection identified while the patient was hospitalised or at the outpatient clinic.

Data were analysed in Microsoft Excel using basic summary statistics.

6.2.8 Ethics

The study satisfied the MSF Ethics Review Board (Geneva, Switzerland) criteria for studies using routinely collected data and was approved by the Comité

National de Bioéthique of Haiti. The study was conducted as a retrospective analysis of routine programme data, and informed consent was thus not sought from study subjects; however, identifying information was removed from all patient records prior to analysis.

6.3 RESULTS

6.3.1 Cité Soleil And Chancerelles, Haiti

While the basic minimum standards for surgery were able to be implemented, it was not possible to instigate the prerequisites needed for internal fixation in the short implementation period. Between 16 January and 25 February 2010, 170 orthopaedic procedures were performed. Table 7.2 shows the different types of procedures that were performed. Amputations and reductions made up the majority of procedures (53 and 33 %, respectively, in Cité Soleil and 18 and 75 %, respectively, in Chancerelles). The intra-operative mortality rate for all orthopaedic procedures was 1.9 % in Cité Soleil and 0.6 % in Chancerelles. Data on postoperative infections could not be captured due to the challenge of follow-up.

6.3.2 Sarthe, Haiti

After Sarthe hospital opened, it took 11 months to implement the prerequisites for performing internal fixation, with the first procedure being performed on 5 January 2011. Between 26 February 2010 and 6 June 2011, 731 orthopaedic procedures were performed, of which 6 % were amputations, 25 % reductions, 15 % external fixations and 17 % internal fixations. From the time when internal fixation began to be performed, it comprised 29 % of the procedures (Table 7.2). There were no intra-operative deaths. Data on postoperative infections could not be captured.

6.3.3 Masisi, DRC

It was not possible to meet the prerequisites for internal fixation (namely adequate infrastructure and sterilisation, and qualified human resources); thus, it was not done. Between 3 September 2007 and 30 June 2014, 597 orthopaedic interventions were performed, of which 20 % were amputations, 48 % were

TABLE 7.2 Surgical activities and outcomes in the six study sites

	Cité Soleil, *n* (%)	**Chancerelles, *n* (%)**	**Sarthe, *n* (%)**	**Masisi, *n* (%)**	**Kunduz, *n* (%)**
Period of study	16/01/10–25/02/10	20/01/10–25/02/10	26/02/10–06/06/11	03/09/07–30/06/14	30/08/11–30/06/14
New surgical cases	292	328	593	10,431	4,480
All surgical OT entries	634	428	1,061	12,909	9,276
All surgical procedures	674	437	1,079	13,658	11,527
All orthopaedic OT entries	103	166	722	584	3,805
Orthopaedic procedures	103	67	731	597	4,026
Amputations	55 (53)	12 (18)	42 (6)	113 (20)	212 (5)
Reductions	34 (33)	50 (75)	185 (25)	285 (48)	1,650 (41)
External fixation	7 (7)	4 (6)	111 (15)	43 (7)	790 (20)
Internal fixation	NA	NA	121 (17)	NA	796 (20)
Others [a]	7 (7)	1 (1)	272 (37)	156 (25)	578 (14)
Intra-operative mortality rate for all surgical procedures	3/634 (0.5)	2/428 (0.5)	1/1,061 (0.1)	50/12,909 (0.4)	4/9,276 (0.3)
Intra-operative mortality rate for orthopaedic procedures	2/103 (1.9)	1/166 (0.6)	0/722 (0)	1/584 (0.2)	2/3,805 (0.05)
Overall postoperative infection rate	ND	ND	ND	3.5 %	2.4 %

OT operating theatre, *NA* not applicable, ND no data available

reductions, 20 % amputations and 7 % external fixations (Table 7.2). The intraoperative mortality rate for all orthopaedic procedures was 0.2 %.

6.3.4 Kunduz, Afghanistan

From the time of the project launch, it took 18 months to put in place the prerequisites for internal fixation, and the first one was performed on 23 January 2013. Between 30 August 2011 and 30 June 2014, 4,026 orthopaedic procedures were performed, of which 5 % were amputations, 41 % reductions, 20 % external fixations and 20 % internal fixations. During 2013, internal fixation procedures accounted for 32 % of all procedures and in 2014 for 38 % (Table 7.2). The intraoperative mortality rate for all orthopaedic procedures was 0.05 %. During 2013, the reported postoperative infection rate was 2.4 %.

6.3.5 Tabarre, Haiti

Built to cater for high-level orthopaedic surgery, three days after opening, the first internal fixation procedure was performed, on 16 February 2012. Between 13 February 2012 and 30 June 2014, 4,119 orthopaedic procedures were performed, of which 2 % were amputations, 16 % reductions, 19 % external fixations and 47 % internal fixations. The proportion of internal fixations performed by year was consistent (Table 7.2). The intraoperative mortality rate for all orthopaedic procedures was 0.03 %. The postoperative infection rate was 2.8 %.

6.4 DISCUSSION

This study demonstrates that in LMIC settings affected by natural disaster or conflict, a high volume and wide repertoire of orthopaedic surgical procedures can be performed with good outcomes when minimum standards are in place. More rigorous procedures like internal fixation may not always be feasible. The high orthopaedic caseloads observed in this study emphasise the strong need for provision of orthopaedic surgery in settings afflicted by natural disaster and conflict. The challenge however is ensuring quality care against a backdrop of limited resources (material and human). Patients can end up paying a high price for substandard surgical care, not least: postoperative infections (including osteomyelitis), disability and even death. The principle of "do no harm" should

prevail at all times; if this principle cannot be upheld, then such surgery should not be undertaken at any cost.

According to the concepts outlined in the Donabedian model, quality of health care can be considered in the context of three domains: "structure", "process", and "outcomes" [14]. Structure describes the factors that affect the context in which care is delivered (e.g. hospital buildings, equipment, human resources); process defines the transactions between patients and providers during the delivery of health care (i.e. those factors that influence how health care is delivered); and outcomes refers to the effects of health care on the health status of patients and populations. The minimum standards of care endorsed by MSF for orthopaedic surgery ensure that all the necessary "structural" elements are in place for maximising quality of care. MSF ensures that important process factors are upheld through comprehensive and standardised protocols for all levels of care (universal precautions and hygiene, clinical therapeutic care: e.g. antibiotic prophylaxis, postoperative pain management, thromboprophylaxis, etc.), appropriate record-keeping in patient files and anaesthesia and surgical records, and comprehensive data collection systems. In this study, we tried to assess the outcomes of these structural and process elements by looking at intra-operative mortality and postoperative infection rates. Low intra-operative mortality and postoperative infection rates across all study sites provide a fair indication that our quality of care is high. Table 7.3 summarises the interaction between structural and process inputs, outcomes and the scope of possible orthopaedic activities in three of our settings.

Basic orthopaedic procedures were possible in all of our study sites, while more demanding procedures such as internal fixation could only be performed at specific sites. Even then, the structural requirements needed to undertake this sort of procedure took as long as 18 months to implement in some settings. Staff expertise and skill level were large determining factors. Basic orthopaedic care can be performed by general surgeons, but more rigorous procedures, like internal fixation, unquestionably require the expertise of trained orthopaedic surgeons. And even when this level of expertise is available, the inherent risks of such a procedure need to be weighed up against the desired functional outcome for the patient; in some cases, conservative treatment of closed fractures may be more appropriate. That all said, we recognise that while internal fixation is among the more demanding procedures in terms of infrastructure and resource requirements, other types of surgical interventions might in fact be better indicated for many of the trauma cases and fractures that present, even when sophisticated operating theatres exist. In many cases, external fixation may be

TABLE 6.3 Summary of key structural and process inputs and their relation to surgical outcomes and the scope of activities that can be performed in Tabarre, Kunduz and Masisi

Setting	Structural components	Structure level	Process components	Process level	Outcomes	Repertoire of orthopaedic procedures
Tabarre	• Sterilisation with segregated dirty and clean areas: yes	Advanced	• Antibiotic prophylaxis and therapy: good	Advanced	Good	• Closed reduction and cast
	• Operating room with reinforced aseptic measures: yes		• Postoperative pain management: good			• Closed reduction with percutaneous fixation
	• CT scan: yes		• Thromboprophylaxis: good			• External fixation
	• Orthopaedic surgeons' level of skills: all are specialists in orthopaedics		• Wound care: high			• Open reduction and internal fixation
	• Nursing care: high					• Intramedullary nailing
Kunduz	• Sterilisation with segregated dirty and clean areas: yes	Advanced	• Antibiotic prophylaxis and therapy: not always followed	Average	Good	• Closed reduction and cast
	• Operating room with reinforced aseptic measures: yes		• Postoperative pain management: not every time followed			• Closed reduction with percutaneous fixation
	• CT scan: yes		• Thromboprophylaxis: good			• External fixation
	• Orthopaedic surgeons' level of skills: mix between specialists in orthopaedics, surgeons and general practitioners with surgical skills		• Wound care: good			• Open reduction and internal fixation
	• Nursing care: good					• Intramedullary nailing

TABLE 6.3 *(Continued)*

Setting	Structural components	Structure level	Process components	Process level	Outcomes	Repertoire of orthopaedic procedures
Masisi	• Sterilisation with segregated dirty and clean areas: no	Average	• Antibiotic prophylaxis and therapy: not always followed	Average	Good	• Closed reduction and cast
	• Operating room with reinforced aseptic measures: no		• Postoperative pain management: not always followed			• External fixation
	• CT scan: no		• Thromboprophylaxis: no			
	• Orthopaedic surgeons' level of skills: general practitioners with surgical skills		• Wound care: good			
	• Nursing care: good					

CT computed tomography

the more appropriate choice of intervention over internal fixation, especially in natural disaster and conflict settings. In this way, even in those settings where the minimum requirements for a procedure like internal fixation do not exist, a high proportion of the trauma caseload may be able to be managed when a procedure like external fixation is possible [15–19].

There were a number of study limitations. First, data on postoperative infection rates were not available at all the study sites. Nonetheless, given that the level of care we provide is standardised across our projects, we would not expect these rates to differ widely from those sites where these data were available. Second, the repertoire of outcome measures in our study was limited to intra-operative mortality and postoperative infection. Other useful indicators would have included infection rates after internal fixation (particularly osteomyelitis) and disability indicators. Complications after internal fixation have been assessed in other MSF trauma centres (namely MSF Operational Centre Paris in its orthopaedic programme following the 2010 earthquake in Haiti, where 5 % of patients with internal fixation required this intervention to be repeated) [20]. Similar results might be expected in our study settings given that the policies, guidelines and protocols are the same.

In conclusion, in settings afflicted by natural disaster and conflict, where orthopaedic needs are high, good surgical outcomes can be achieved when context-specific minimum standards are in place. We make a strong call for providers of surgical health care in any setting, particularly LMIC settings, to ensure that minimum standards of care are in place before such surgery is undertaken and to avoid more rigorous procedures when these standards cannot be met.

REFERENCES

1. World Health Organization (2010) Injuries and violence: the facts. World Health Organization, Geneva.
2. Peden M, McGee K, Sharma G (2002) The injury chart book: a graphical overview of the global burden of injuries. World Health Organization, Geneva.
3. Weiser TG, Regenbogen SE, Thompson KD, Haynes AB, Lipsitz SR, Berry WR, Gawande AA (2008) An estimation of the global volume of surgery: a modelling strategy based on available data. Lancet 372:139–144. doi:10.1016/S0140-6736(08)60878-8
4. Chu KM, Ford N, Trelles M (2010) Operative mortality in resource-limited settings: the experience of Medecins Sans Frontieres in 13 countries. Arch Surg 145:721–725. doi:10.1001/archsurg.2010.137
5. Nickerson JW, Chackungal S, Knowlton L, McQueen K, Burkle FM (2012) Surgical care during humanitarian crises: a systematic review of published surgical caseload data from foreign medical teams. Prehosp Disaster Med 27:184–189. doi:10.1017/S1049023X12000556

6. Wong EG, Gupta S, Deckelbaum DL, Razek T, Kushner AL (2015) Prioritizing injury care: a review of trauma capacity in low and middle-income countries. J Surg Res 193:217–222. doi:10.1016/j.jss.2014.08.055
7. Timmermans S, Berg M (2003) The gold standard: the challenge of evidence-based medicine and standardization in health care. Temple University, Philadelphia
8. Pope C (2002) Contingency in everyday surgical work. Sociol Health Illn 24:369–384. doi:10.1111/1467-9566.00300
9. The Sphere Project (2004) Humanitarian charter and minimum standards in disaster response. 2004 edition. http://www.unrwausa.org/document.doc?id=7. Accessed 6 Feb 2015.
10. World Health Organization (2012) Guide to infrastructure and supplies at various levels of health care facilities. World Health Organization, Geneva, www.who.int/surgery/publications/s15983e.pdf. Accessed 6 Feb 2015.
11. Hoencamp R, Tan E, Idenburg F, Ramasamy A, van Egmond T, Leenen L, Hamming J (2014) Challenges in the training of military surgeons: experiences from Dutch combat operations in southern Afghanistan. Eur J Trauma Emerg Surg 40:421–428. doi:10.1007/s00068-014-0401-z
12. Chu K, Stokes C, Trelles M, Ford N (2011) Improving effective surgical delivery in humanitarian disasters: lessons from Haiti. PLoS Med 8:e1001025. doi:10.1371/journal.pmed.1001025
13. Wong E, Trelles M, Dominguez L, Gupta S, Burnham G, Kushner AL (2014) Surgical skills needed for humanitarian missions in resource-limited settings: common operative procedures performed at Médecins sans Frontières facilities. Surgery 156:642–649. doi:10.1016/j.surg.2014.02.002
14. Donabedian A (1966) Evaluating the quality of medical care. Milbank Mem Fund Q 44:166–203.
15. Hinsenkamp M (2014) SICOT contribution to natural disaster assistance: the external fixator. Int Orthop 38:1549–1550. doi:10.1007/s00264-014-2413-z
16. Boillot F, Herard P (2014) External fixators and sudden-onset disasters: Médecins Sans Frontières experience. Int Orthop 38:1551–1554. doi:10.1007/s00264-014-2344-8
17. Bertol MJ, Van den Bergh R, Trelles Centurion M, Kenslor Ralph DH, Basimuoneye Kahutsi JP, Qayeum Qasemy A, Jean J, Majuste A, Kubuya Hangi T, Safi S (2014) Saving life and limb: limb salvage using external fixation, a multi-centre review of orthopaedic surgical activities in Médecins Sans Frontières. Int Orthop 38:1555–1561. doi:10.1007/s00264-014-2451-6.
18. Awais S, Saeed A, Ch A (2014) Use of external fixators for damage-control orthopaedics in natural disasters like the 2005 Pakistan earthquake. Int Orthop 38:1563–1568. doi:10.1007/s00264-014-2436-5
19. Mathieu L, Ouattara N, Poichotte A, Saint-Macari E, Barbier O, Rongiéras F, Rigal S (2014) Temporary and definitive external fixation of war injuries: use of a French dedicated fixator. Int Orthop 38:1569–1576. doi:10.1007/s00264-014-2305-2
20. Teicher CL, Alberti K, Porten K, Elder G, Baron E, Herard P (2014) Médecins sans frontières experience in orthopedic surgery in postearthquake Haiti in 2010. Prehosp Disaster Med 29:21–26. doi:10.1017/S1049023X13009278

PART IV
Managing Resources During a Disaster

CHAPTER 7

The Challenge of Allocating Scarce Medical Resources during a Disaster in a Low Income Country: A Case Study from the 2010 Haitian Earthquake

Annekathryn Goodman and Lynn Black

7.1 INTRODUCTION

Natural disasters in low-income countries rapidly deplete available medical and social resources. Rescue teams are confronted with the challenge of medical triage of critically ill patients when there are not enough supplies to treat everyone. The complex and challenging decision to shift from active to palliative care in the disaster setting is rarely straightforward. The experience of one disaster team during their deployment after the 2010 Haiti earthquake is described and analyzed.

The National Disaster Management System (NDMS) of the United States recruits volunteer health professionals who train for disasters and are called up when the United States government declares a national or international

disaster [1]. When on deployment, the disaster team members are federal employees. The command structure of NDMS follows the incident command system of the military. In Haiti, our team received our orders from our Commander-in-Chief (CIC) in Washington. On the ground, a direct commander in chief was selected. The organization structure of the team followed the incident command structure set by our CIC. Our CIC was an EMT fireman. He organized the 63-team members into modules based on our work assignments. Because we were working in an unsafe environment physically (there were daily aftershocks and unstable buildings) and politically (there was no effective government in Haiti and there were riots, looting, and gang violence), safety and security was the first priority of the CIC. One of the modules in our group was logistics. They were involved in obtaining supplies to keep our hospital running. All supplies including medicines, medical equipment, food, and shelter were brought in from the United States. The team did not use any local resources so as to not deplete locally scarce supplies.

A chief medical officer was assigned to coordinate the medical efforts of the group. Daily briefings were held by the CIC about safety reports, supplies, team safety. The sign-out among the nurses and doctors occurred every 12 hours in their particular tent

This report describes three patients who required oxygen when oxygen supplies were running out. The dilemma of triage is discussed and ethical questions are raised. How does one decide whom to give a limited resource to? How is this decision made? Who is responsible for making this decision? What is the impact on the medical team of rationing or withdrawing resources? One solution, to develop an embedded ethics presence within the team to guide and validate these dif cult decisions, is discussed.

7.2 CASE REPORT

United States Health and Human Services sent Medical Disaster Teams into Haiti after the January 12, 2010 earthquake. Our team of 63 people (including 11 physicians, 29 nurses, 3 pharmacists, 2 respiratory therapists, and 18 logistics and security people) arrived in Haiti forty-eight hours after the earthquake. A perimeter and a mobile hospital unit were set up in a devastated region of Port Au Prince on the grounds of a destroyed hospital called Gheskio. There were two general medicine tents, a minor procedures tent for dressings and debridements, an operating room, "ICU", and children's ward. We were able to shelter

35 souls at a time and tried to triage, treat, and discharge patients quickly. From the time the hospital was set up, we worked at full capacity and sheltered an additional twenty to thirty patients on army cots covered by mosquito netting on the grass perimeter.

We were surrounded by a tent city of survivors, rubble from buildings, and the constant shifting ground of aftershocks. Because the airport had been severely damaged and transport resources were devoted to a constant stream of people being airlifted out of Haiti, there was limited delivery of medicines, supplies, and food into Haiti during the first two weeks after the earthquake.

Supplies were initially insufficient. For instance, while the most common injury was compound fractures of the arms, legs, and hips, external fixators were not available until our second week. Creative solutions included tying pieces of stone from the rubble to ropes swung over the poles of the army cots to use traction to realign the fractures.

One week after the earthquake, three critically ill patients arrived simultaneously to the Gheskio Field Hospital. N.S. was a 38-year-old woman who had decompensated congestive heart failure. She had been an inpatient at the University Hospital before the earthquake destroyed parts of the hospital. Her family had all died when their house crushed them. She was brought to us in severe respiratory distress. She received diuretics and oxygen.

J.P., the second patient, was a 25-year-old man who had survived under the rubble for three days until his family was able to dig him out. His severe crush injuries led to renal failure and then acute respiratory distress syndrome. He was emergently intubated and put on the respirator in the ICU tent.

The third patient was an infant with pneumonia who was intubated and ventilated manually as there was only one mechanical respirator at the field hospital.

On the morning that the three patients arrived, the chief logistics officer informed us that we were getting low on oxygen and gasoline. He was concerned that we would run out of gasoline used to run our generators. Requests for these supplies had been made but because of the precarious situation at the airport, it was uncertain when we would receive the needed supplies. Other medical supplies such as pain medication, antibiotics, and cardiac medications were adequate.

By that evening, it was clear that oxygen supplies were low; however there was no group meeting called to discuss how to manage the crisis. By midnight, oxygen supplies were running out. In the medical tent where N.S. was being treated, the medical officer made the decision to turn down the flow rate of her oxygen tank to try to ration it. She was treated with more diuretics and

morphine to alleviate her panic from respiratory distress. The nurse taking care of N.S. spent the night trying to keep her comfortable. By morning, when the communications liaison identified another facility with resources, N.S. was transported without oxygen by a pickup truck to University Hospital in Port au Prince where oxygen was available. A doctor from our team transported her and tried to palliate her discomfort with inhalers. N.S. survived and was discharged after treatment.

J.P. and the infant were being managed in the ICU tent. The baby was hand ventilated using room air when her oxygen tank ran dry. The two respiratory therapists and the one pediatrician took turns squeezing the Ambu bag for 24 hours. The pediatrician who was ventilating the infant suggested that J.P. should not be intubated when he developed respiratory distress and be allowed to die. The other physician in the tent refused and intubated him. J.P. was given the last remaining tank of oxygen. The baby and J.P. were transported by helicopter to the USNS Comfort Hospital Ship that was docked in the harbor. J.P. died en route. The baby survived.

7.3 DISCUSSION

7.3.1 Triage in a Disaster Setting

Disaster triage includes assessing survivors for types of injuries and survivability from injuries. Triage categories are described based on the need for immediate versus delayed care, and scoring systems or universal color coding are used for quick communication of triage assessments [2]. For instance, an immediate triage category (color red) signals a group needing immediate attention to survive. The delayed category victim (color yellow) has wounds that can be treated after the red group. The minimal category victim (color green) does not have life threatening injuries and can be managed at a later time. The expectant category (color black) will not survive and the focus should be on palliative care with a goal of alleviating suffering.

At the Gheskio Field Hospital, both the infant and J.P. had category red medical conditions. N.S, chronically ill for years was initially thought to be category yellow but actively decompensated when oxygen was withdrawn. All three patients were believed to have life-threatening conditions that could be reversed with the right therapeutic interventions.

7.3.2 Resource Availability

Resource availability is categorized as Normal, Good, Fair, and Poor [3]. With normal resources (categorized as "conventional" by the Institute of Medicine (IOM)), normal care is provided. For good resource availability (categorized as "contingency" by IOM), the functional equivalent level of care can be maintained by substituting and conserving resources. Fair resources are considered in the "crisis" category by IOM and triage is needed to prioritize those with moderate life threatening injuries. The rational for this is that those with more severe life-threatening injuries will have higher resource requirements and worse prognosis even with treatment. For poor resource availability (also categorized as "crisis" by IOM), moderate life-threatening injuries are prioritized but resources can be inadequate to treat even this group. Severe causalities are triaged to the expectant category.

Resources at Gheskio Filed Hospital were temporarily poor and in the "crisis" category for resource availability after a week of continuous disaster work in Haiti. The team hoped to keep the category red patients alive until more resources arrived. However, oxygen ran out before the camp could be resupplied. Using the IOM analysis, the survivability of these three patients should have been reconsidered. While J.P. was young and healthy, he had sustained a devastating injury and was developing multi-organ system failure. Realistically, the likelihood of his survival was low. However, it was emotionally impossible for the staff caring for him to disengage. This led to conflict among team members. A strong leadership presence with a "group huddle" to discuss events would have been helpful. In addition to these three patients, there were multiple other medical crises going on including a woman with a dysfunctional labor, five small children with amputations, and four people in the "expectant" category which included a woman dying of tuberculosis and AIDS, a woman with a severe crush injury, a pregnant woman with a broken neck, and a boy with tetanus. The CIC was chosen because of his strong logistics and security background, however because of his expertise in these areas, there was less leadership guidance on the challenges of medical management. Using the same analysis, while in an environment with normal and "conventional" resources, N.S. would have been fitted with a home oxygen tank. She also might have been on a heart transplant list. In Haiti, a country without a single functioning hospital in Port Au Prince, it was only a matter of time before her chronic condition would deplete available resources. Given the huge need of other people who did not have chronic conditions and who could survive, one might argue that oxygen should be saved for

them. The staff caring for N.S. could not make that decision and continued to give her the remaining oxygen.

7.3.3 Team Dynamics, Psychological & Behavioral Responses to Disaster Care

Our team and NDMS teams in general are required to participate in trainings through the year. Drills with volunteer victims to learn how to triage casualties and allocate scarce resources are routinely performed. Yet in the heat of real crisis, the primary role as patient advocates collided with the intellectual knowledge of triage developed from drills. Therefore, it is important that part of leadership in the disaster setting involves constant guidance and discussion when these distressing decisions arise about whom to treat and whom not to treat. Studies of emergency responders show that they have a powerful sense of duty and deep commitment to help [4]. Despite adequate pre-disaster training, dysfunctional behavior can occur when responders are vastly overwhelmed and severely under-resourced. Additionally, dysfunction occurs when there are threats to personal safety and limited information about what is happening globally. In our team, we were physically uncomfortable due to the austere environment and heat. The air was filled with smoke from res in buildings, from burning of bodies, and from burning of tires during riots. There was wide spread frustration at the lack of adequate supplies. There was limited communication with the outside world and with other rescue sites on the ground because of a lack of cell phone function and destruction of land-line communications.

In the setting of severe stress, decision-making can be adversely affected. During Hurricane Katrina, thirty-four patients died at Memorial Medical Center. The staffs, who were not trained in disaster management, made decisions about patient care and triage that were later questioned. One editorial concluded that training and community discussions about what care should be provided when there are crisis category resources after a disaster [5]. Our experience in Haiti suggests that training is not enough.

7.3.4 Ethical Resources for Disaster Work

Theoretical ethical analyses of disasters offer ethical frameworks to help professionals identify the obligation to preserve life, name crises in resources, and even to consider euthanasia in settings of irresolvable suffering [6]. Pre-disaster

training is important. Other tools include Edwards and Robey's "Virtual Mentor" [7]. They discuss three strategies for approaching ethical issues:

1. anticipate and practice;
2. use pre-existing ethical frameworks;
2. build a scaffolding within which to place issues.

Hunt discusses the importance of establishing "moral bearings" in humanitarian work [8]. He identifies specific challenges that impact the uncertainty of the ethical decision-making in acute emergencies that include:

1. the level of achievable care is much lower than health care providers are used to;
2. in contexts of resource scarcity, increased instability, and widespread health needs, population health concerns abound;
3. in humanitarian settings the volume and urgency of needs of the local population are elevated and providers often work extremely long shifts causing exhaustion and have limited opportunity to debrief.;
4. important differences exist between cultural frameworks in how health, wellness, disease and disability are understood and experienced;
5. imbalances of power occur between providers and patients; and
6. there is less regulatory oversight and professional accountability in the field than at home.

Hunt suggests asking several focused questions to help understand the appropriate action. These questions listed here in italics could have guided decision making during our dilemma of managing the three patients who required the diminishing supply of oxygen:

1. Identify/clarify the ethical issue

a) *What is the issue that we are experiencing*?
Who should receive the limited oxygen resource?

b) *What is at stake and for whom?*
All three patients are at risk of dying without the oxygen.

c) *How is this issue experienced/understood from different perspectives?*
All of the team is aware of the consequences of withdrawing oxygen from the three patients. There was disagreement about who should receive oxygen based on differing assessments of survivability.

2. Data gathering and attention to context

a) Who can contribute to helping us understand this issue better?
Information about when more supplies could be obtained would have been helpful. Understanding what resources other NGO tent hospitals in the area had available would have allowed earlier transfer of patients that we could not have taken care of.

b) How do organizational features influence the issue?
There was no embedded ethics committee within the organization of our team on the ground. It would have defused the tension to have an ethics subgroup of the team assigned to support team members about the dilemma of choice of who would receive oxygen. An ethics presence could have also weighed-in on who was the most appropriate recipient of our scarce resource.

c) What is the impact of the professional and social norms of our home countries on how we understand this issue?
The professional norms of the team heavily impacted the choices they made. The physician who decided to intubate J.P was an emergency room physician who could not watch the young man die when she knew she could prevent his death by intubation. The nurse, who worked in an intensive care unit in her home hospital, was traumatized by watching N.S. gasp for air all night long because of inadequate oxygen.

d) What is the impact of this issue on collaboration and trust among the team?
The team works because of collaboration and an acceptance of command decisions. When a situation such as running out of oxygen occurs, this stresses the trust relationship between team members. Trust between team members requires that there is open communication and collaborative problem solving.

e) How are imbalances of power relevant to the issue?
The command structure prevented a flexible problem-solving approach in this situation of crisis. The command focus was on the safety of the team members and did not allow problem solving about ethical issues. The choice of a logistics and security expert understandably occurred because of the unstable nature of the country. However, greater thought to structuring a medical leadership should have also occurred.

3. Exploration of ethics resources

a) What ethics resources and approaches can assist us in evaluating this issue?

The most important resource would have been an a priori establishment of an in-team ethics group. It would have been important to give the ethics group authority to weigh-in on contentious issues. The values and norms continue to be the observance of triage of victims by severity of injury plus an acknowledgement of the scarcity of resources. Group discussion of these limitations and emotional support to team members in distress is vital.

7.3.5 The Ethical Landscape of a Disaster

Disaster responders have a moral compulsion to help in a disaster. They come into the disaster environment with a developed sense of ethical justice. Justice in this setting includes a sense of obligation to the victims. In the field, the lack of resources and the overwhelming number of injuries and victims can lead to despair and post-traumatic stress on the part of the providers. Providing an ethical framework and a moral landscape can lighten the burden of these providers, reduce tension between colleagues, and help with dif cult decisions. Edwards and Robbey [7] review the four ethical skills of:

1. Recognition: What is the ethics issue in this case? Reasoning: What options are there, and what are the potential harms and benefits of each? What is at stake in this decision?
2. Responsibility: What are my professional obligations?
3. Respond: What will I do, and why?

This simple articulation frames the most terrible of dilemmas. Additionally, the need for a disaster ethics committee takes the burden of these "Sophie's Choices" off the individual providers. There is a need for training of selected individuals on the disaster team in ethics. The most workable model for an ethicist(s) on a disaster team is ethicist as a team member [9]. The wisdom of who should decide life and death decisions in a non-disaster setting is useful to support a similar practice in the disaster setting. Decisions should reflect the various segments of the community and no decisions can be made in isolation of that community [10]. Disaster medicine occurs within the fabric of

a community that has been damaged or destroyed. One of the challenges of a disaster team is to identify local cultural leaders to help guide decisions. The ethics subgroup within the team should be tasked to explore community resources.

The United States National disaster team is, by its nature, a team that is trained to accept the authority of its commanders. The addition of an ethicist as an authority would be well received. The nature of authority per se and for an ethics consultant has been explored [11]. The two components to authority are epistemic and competence. Additionally, authority in action solidifies the status of the ethicist. This would definitely occur in the disaster field. Finally, the disaster team ethicist can help open up a moral space for discussion among team members. Having such a resource on the team emphasizes the importance of these issues in both decision-making and in the support of the team members. There is a need to find some existential meaning to the outcomes of disasters. Disaster responders feel that their participation in the alleviation of suffering gives meaning to the chaos and misery. The available ethical tools should be deployed to help bring clarity to impossible situations and prevent team members from feeling isolated when tough decisions need to be made.

7.3.6 Communication as Part of Ethics Work in Disasters

Decision making in disasters should use five domains to help guide responders: triage and allocation, ethical concerns of patients and families, ethical responsibilities to providers, conduct of research, and international concerns [12]. This report focuses on the dilemmas providers confront in the first domain: triage and allocation.

Disaster management communication is vitally important during disasters [13]. Developing a language of quick sign-outs to identity ethical issues will help teams work efficiently and reduce conflict. Research is needed into responders' choices and how to best develop guidelines [14]. Additional training with real life scenarios, development of triage plans, and the use of ethics consults can minimize the burden of emotional and cognitive dissonance on providers in the field [15].

REFERENCES

1. Ebola Information for Healthcare Professionals and Health- care Settings, 2014. http://www.phe.gov/preparedness/pages/ default.aspx. Accessed February 13, 2015.

2. Eastridge BJ, Butler F, Wade CE, et al. Field triage score (FTS) in battle field casualties: validation of a novel triage technique in a combat environment. J Surg. 2010; 200(6): 724-727. doi: 10.1016/j.amjsurg.2010.08.006
3. Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations. http://www.iom.edu/reports/2009/disaster- carestandards.aspx. Accessed February 13, 2015.
4. Dodgen D, Norwood AE, Becker SM, Perez JT, Hansen CK. Social, psychological and behavioral responses to a nuclear detonation in a US city: implications for health care planning and delivery. Disaster Med Public Health Preparedness. 2011; 5: S54-S64. doi: 10.1001/dmp.2011.12
5. Okie S. Dr Pou and the Hurricane—Implications for patient care during disasters. NEJM. 2008; 358: 1-5. doi: 10.1056/ NEJMp0707917
6. McCullough LB. Taking seriously the "what then?" question: an ethical framework for the responsible management of medical disasters. J Clin Ethics. 2010; 21: 321-327.
7. Edwards KA, Robey T. "Preparing for the Unexpected: Teaching ER Ethics". American Medical Association Journal of Ethics. 2010; 12(6): 455-458. doi: 10.1001/ virtualmentor. 2010.12.6.medu1-1006
8. Hunt MR. Establishing moral bearings: ethics and expatriate health care professionals in Humanitarianwork.Disaster.2011;35(3):606-622.doi:10.1111/j.1467-7717.2011.01232.x
9. Fox MD, McGee G, Caplan A. Paradigm for clinical ethics consultation Practice. Cambridge Quarterly Healthcare ethics. 1998; 7: 308-314.
10. McGee DB. Issues of Life and Death. Understanding Christian Ethics an interpretive approach. In: Tillman W, ed. B&H Publishing Group. 1988; 11: 227-248.
11. Agich GJ. Why should anyone listen to Ethics consultants? The Philosophy of Medicine. In: Engelhardt HT Jr, ed. Copyright 2000, Kluwer Academic Publishers, Netherlands. 117-137. doi: 10.1007/0-306-47475-1_6
12. Biddison LD, Berkowitz KA, Courtney B, et al. Ethical considerations: care of the critically ill and injured during pandemics and disasters: CHEST consensus statement. Chest. 2014; 146(4 Suppl): e145S-e155S. doi: 10.1378/chest.14-0742
13. Bradley DT, McFarland M, Clarke M. The effectiveness of disaster risk communication: a systematic review of intervention studies. PLoS Curr. 2014; 6.
14. Mathúna D. Research ethics in the context of humanitarian emergencies. J Evid Based Med. 2015; doi: 10.1111/ jebm.12136
15. Ozge Karadag C, Kerim Hakan A. Ethical dilemmas in disaster medicine. Iran Red Crescent Med J. 2012; 14(10): 602-612.

CHAPTER 8

Review of Relief Demand Forecasting Problem in Emergency Logistic System

Jianan Zhao and Cejun Cao

8.1 INTRODUCTION

In the past few decades, with the frequency of emergencies increasing, the result is a worsening negative effect on the society and the economy. For example, Sarin gas attacked on Tokyo subway in 1995. Severe Acute Respiratory Syndromes (SARS) as an epidemic disease spread in 2003 in China. The southern big snowstorm and Wenchuan earthquake happened in 2008 in China. In addition, the earthquake occurred in Yaan and Chile, and so on. All these emergencies lead to heavy loss of human lives and property [1]. An enormous amount of relief is required in order to reduce or relieve this loss. And the suddenness of these emergencies shows that it is difficult to predict or the interval time between forecasting and occurrence, which is extremely short. All this puts forward new challenges for emergency logistics system. Therefore, this paper focusing on an emergency logistic system that has certain practical significance.

The emergency logistic system discussed here indicates that an emergency situation, to meet (or finish) the urgent (or sudden) logistic demand of the victims. This is the process of effective planning, managing, and controlling relief efforts, (sudden) logistic demands of victims; it is also the process of effective planning, managing, and controlling of relief efforts, information and rescue

service from supply point to demand point. Improving the accuracy and reliability of relief demand forecasting is an effective solution to reduce or relieve the serious results of emergencies. By analyzing the relief types and characteristics of relief demand, it shows that a reasonable and proper forecasting method can make for distributing relief efficiently and quickly as well as avoiding the phenomenon that supply-demand imbalance and relief distribution delay. Therefore, the study of the relief demand forecasting problem in emergency logistic system has a certain practical and theoretical significance.

In comparison, research has mainly focused on relief transportation and distribution in the emergency logistic system [2]. And the relief demand amount to affected areas is known as indicated in this literature. It is treated as a prerequisite. However, during the emergency response process, in reality, it is difficult to obtain the information (e.g. quantity, type, demand structure, etc.) about relief demand because of being limited by various objective conditions. Recent years, aiming at this problem, scholars have applied various theories, methods and techniques to predict the relief demand amount of each affected area in the emergency logistic system. Meanwhile, there are a lot of achievements. These methods can be classified into two groups, namely quantitative and qualitative methods. Qualitative method or theory includes Fuzzy Comprehensive Evaluation (FCE) [1], Analytic Hierarchy Process (AHP), and Delphi. Quantitative method or theory includes time-series [3] [4], comprehensive analysis [5], case-based reasoning [6]-[9], information entropy [10], and safety stock [11], and so on. Above all, the techniques or technologies of relief-demand forecasting completely developed from qualitative analysis to combine qualitative with quantitative methods, and from linear statistical analysis to the nonlinear artificial intelligence method.

In this paper, we categorize relief from the point view of government and academia, and then explain the relationship between relief categorization and demand forecasting. Then we look at the characteristics of relief-demand, such as suddenness, uncertainty, timeliness, and stage. Finally, an overall conclusion on the current development of relief demand forecasting method is given.

8.2 RELIEF CLASSIFICATION IN EMERGENCY LOGISTIC SYSTEM

Relief work discussed here refers to all types of material needed during the emergency response process. It is necessary to classify all relief in order to enhance the efficiency of scheduling and the forecasting accuracy of relief demand. Relief

classification enhances emergency preparedness and readiness by the whole community through a system that allows jurisdictions to augment their capabilities during an incident.

8.2.1 Relief Classification from the Point View of Government

There are many classification methods on relief work at home and abroad. For instance, Federal Emergency Management Agency (FEMA) mentioned that relief can be classified into nine categories, namely:

1. emergency medical services resources
2. incident management resources
3. medical and public health resources
4. law enforcement resources
5. public works resources
6. search and rescue resources
7. mass care resources
8. fire and hazardous materials resources
9. animal emergency response resources

Each category is compiled separately in the manual.

In Japan, according to the application of relief, disaster emergency material includes three categories, namely:

1. foods
2. daily articles
3. self-help tools

Australian Federal Government Emergency Management Agency divides relief into physical resources and technical resources in their Overseas Disaster Rescue Plan. And resource in emergency management arrangement includes search and rescue resources, medical aid resources, foods and others.

Emergency support material classification and production list made by the Ministry of Civil Affairs of the People's Republic of China shows that relief can be divided into thirteen categories, namely:

1. protective equipment resources
2. life-saving resources

3. life support resources
4. load and transport resources for rescue
5. temporary accommodation resources
6. pollution and clean-up resources
7. power fuels resources
8. engineering equipment resources
9. engineering materials resources
10. equipment tools resources
11. lighting equipment resources
12. radio communication
13. resources and transport resources

8.2.2 Relief Classification from the Point View of Academia

In the literature [12], professor Fiedrich from Karlsruhe University of Germany treated initial or key rescue stage in earthquake disaster as his object. Relief efforts are defined as the machines and equipment which can be used to simultaneously work at different affected areas. In detail, they include six categories, namely:

1. search-and-rescue group (to accomplish rescue tasks)
2. crane (to accomplish lift tasks)
3. hydraulic excavator (to use for lift and load tasks)
4. wheeled loader (to use for load tasks)
5. truck (to accomplish transport tasks)
6. roller (to use for compact tasks)

However, this literature only focuses on different equipment used in search and rescue areas, stabilizing areas, and rehabilitation areas. And it belongs to similar resource allocation problems.

In other literature [10] [11], considering the emergency logistic distribution problem for quick response to urgent relief demand during earthquakes, professor Sheu from National Chiao Tung University in Taiwan considers two types of urgent relief needed in affected areas including, daily used equipment for refugees and daily consumed relief. What's more, the former mainly refers to water and meal boxes, and the latter refers to sleeping bags and camps.

In still other literature [13], based on the characteristics of rescue operational process in flood disaster management, Qin from Xi'an Jiaotong University in China mentioned that these necessary emergency materials can be classified into two categories, namely response resources (e.g. sandbags and protection network) and recovery resources (e.g. food and medicine). During the process of emergency handling, the relationship between the two relief efforts is independent. However, due to the complexity and seriousness of this problem, this relationship is non-linear and stochastic. In addition, some scholars have divided the relief needed in emergency management of drought disaster into pumping equipment and irrigation equipment.

According to the detailed description given above, we can conclude that emergency relief comes in various types. The forecasting methods for different types of relief are various (or they make a distinction between these methods). So relief classification is the prerequisite and basis in terms of forecasting relief-demand amounts in emergency logistic systems. During the emergency response process, if only to master the relief classification related information clearly, the amount of relief-demand can be predicted exactly.

8.3 RELIEF DEMAND FORECASTING IN EMERGENCY LOGISTIC SYSTEM

8.3.1 The Characteristics of Relief Demand

After an emergency, the relief demand in the affected areas has four features:

1. suddenness
2. uncertainty
3. timeliness
4. stage

8.3.1.1 The Sudden of Relief-Demand

Suddenness is the most typical characteristic of emergency. This suddenness reflects not only the accidental occurrence of emergency but also the change process of disaster elements from quantity to quality. It is this suddenness of emergency that leads also to the suddenness of relief-demand.

8.3.1.2 The Uncertainty of Relief-Demand

This characteristic is relatively obvious by comparison with the traditional materials demand. With the development of the emergency response process, the relief demand in the affected area is dynamically varied. The consequences or phenomenon of an emergency, such as serious damage to infrastructure, the blocking of communication, and the block of transportation, results in some information being unable to be obtained in time. This information is involve with the total number of fatalities, the population consistency, and the degree of damage in the affected area. The unsymmetrical phenomenon of information occurs between the victims and decision-makers. Thus the amount and type of relief demand raises uncertainty.

8.3.1.3 The Timeliness of Relief-Demand

Time is the key factor that needs to be considered with the relief allocation problem during the emergency response process. Relief transportation from supply point to demand site or the affected area should be accomplished as soon as possible. That is the primary task during emergency response process. Time is limited for decision-makers after emergency. It is necessary to make the relief allocation scheme in time for decision-makers instead of missing the best chance. In addition, the timeliness of relief arriving at the affected area has a direct effect on the range damage caused by the emergency. To a certain extent, if relief efforts arrive in time it can reduce the occurrence frequency of a sub-emergency or secondary emergency. Thus it can relive the loss caused by emergency.

8.3.1.4 The Stage of Relief-Demand

The emergency response process can be refined to three stages in terms of golden rescue stage, buffer rescue stage, and the recovery stage [14]. Different stages have different relief-demand structures. For example, the large rescue equipment and medicine articles are rare during the golden rescue stage. In the buffer rescue stage, the quantity of demand on tents and foods has a larger scale. Analyzing the characteristics of relief-demand properly is good step toward identifying the focused or key problem during the process of designing a relief demand forecasting method in the emergency logistic system.

8.3.2 Relief Demand Forecasting Method in Emergency Logistic System

The process of relief allocation in an emergency logistic system involves four parts:

1. relief-demand forecasting
2. groping the affected area
3. classification of the victims
4. relief distribution

It is depicted in Figure 9.1 in detail.

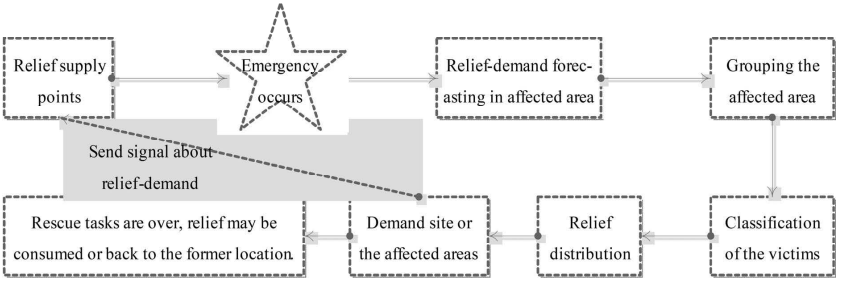

FIGURE 8.1 The relief distribution process of emergency logistic system. Data source: finished based on literature [10]-[11] [14] by authors.

According to Figure 8.1, we can find that relief demand forecasting in the affected area plays an important role in the process of distribution. The rescue effects directly depend on the accuracy of relief-demand forecasting.

Meanwhile the selection of a forecasting method is the key problem. Recently, there's a lot of research in the field of relief-demand forecasting methods in emergency logistic system. Also there are more fruitful achievements.

In this paper, on the basis of relief classification, by analyzing the characteristics of relief-demand, we make a conclusion about a relief demand forecasting method in an emergency logistic system in terms of quantitative method and qualitative method.

8.3.2.1 The Qualitative Methods of Relief Demand Forecasting

At the beginning of emergency management, traditional relief-demand forecasting of the affected area mainly depends on decision-makers' experience and experts' judgment subjected to various limitation constraints. The expert scoring method has been applied widely into relief-demand forecasting, including Delphi, Fuzzy Comprehensive Evaluation (FCE), and Analytic Hierarchy Process (AHP). To a large extent, the expert scoring method is suitable for complex relief-demand forecasting. But this method is too subjective to explain. Above all, the application of this method in relief-demand forecasting of real emergency is limited seriously. For instance, Sun [1] proposed a fuzzy rough set approach to emergency material demand prediction over two universes.

8.3.2.2 The Quantitative Methods of Relief-Demand Forecasting

The qualitative method can't adapt well to emergency management over time. Based on qualitative analysis, scholars have introduced various quantitative methods to predict the relief-demand amount in the emergency logistic system. With the development of emergency management and statistics, scholars begin to apply some statistics analysis methods to the field of relief-demand forecasting. They are mainly time-series forecasting methods (e.g., Autoregressive and Integrated Moving Average-ARIMA, exponential smoothing models, and independent identical distribution models) and comprehensive analysis methods. However, the amount of relief-demand after an emergency usually shows a great deal of non-linear and non-regulatory attributes, which result in the traditional statistic method being ineffective for forecasting. What's more, the quantitative methods include the artificial intelligence model (e.g. Neural Networks), case-based reasoning, information entropy theory, and safety stock modelling. The following section will concentrate on the latter three methods' application in the field of relief-demand forecasting in emergency logistic system.

8.3.2.2.1 Relief Demand Forecasting Based on Case-Based Reasoning

The case-based Reasoning (CBR) method is proposed in dynamic memory written by Roger in 1982. It has been applied and gradually verified by his students over time. In recent years, scholars have begun to apply CBR method to relief-demand forecasting. In detail, it involves unconventional emergency, water transport emergency, and public emergency. The representatives of this approach include Professor Liu of Tsinghua University, Professor Liu Mao of Nankai University, Professor Zhuang Yaming of Southeast University, and Deng Shoucheng, engineer. All in all, relief-demand forecasting based on CBR is composed of retrieve, reuse, revise and retain [15], which is depicted in Figure 9.2.

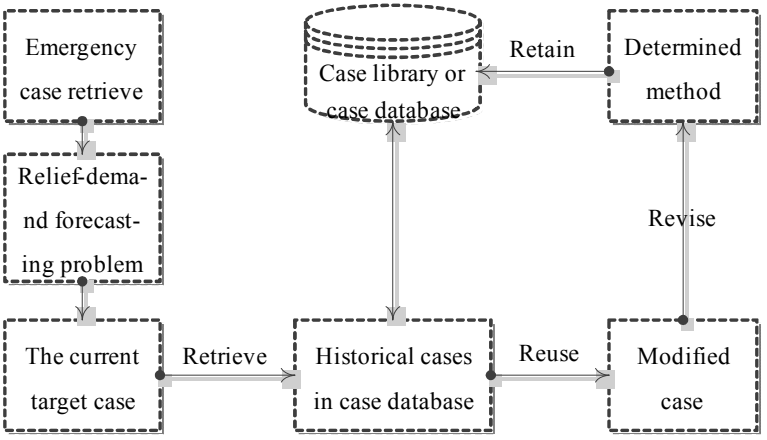

FIGURE 8.2 Process of relief-demand forecasting based on CBR. Data source: finished based on literature [15] by authors.

In detail, the process of CBR can be described as follows. Analyze the influencing factors of relief-demand based on relief classification by combining with the characteristics of relief-demand forecasting process. Then abstract the features of indexes, determine the weight of the index, calculate the similarity between the target case and source case based on the formula (9.1), and obtain the amount of relief in the target case or emergency.

$$Sim(T, C_i) = \frac{\sum_{j=1}^{m} w_j (n_T(x_j) \vee n_{C_i}(x_j))}{\sum_{j=1}^{m} w_j (n_T(x_j) \wedge n_{C_i}(x_j))} \geq \eta, i = 1, 2, ..., n \quad (8.1)$$

In formula (8.1), the target case is denoted by *T*, the source case is denoted by C_i, and the similarity between target case and source case is denoted by *Sim(T,C)* . Relief-demand forecasting based on the Case-based Reasoning method needn't depend on the infinite model. It improves the efficiency of solving the problem by reusing the past solutions. At the same time, it can cause continuous learning by acquiring new knowledge from the cases.

8.3.2.2.2 Relief Demand Forecasting Based on Information Entropy Theory

Entropy theory was put forward by Rudolf Clausius, and first applied to thermodynamics field. With the development of this theory, its applications became wider. Up until 1948, Shannon was the first scholar to introduce entropy into the information field. Professor Sheu [10] assumed that the time-varying relief demand needed in a given affected area is highly correlated with the number of survivals. Based on this prerequisite, some literature [10] studied daily-consuming relief, such as water, meal boxes and so on, as a distribution problem. They then proposed an entropy-based weighting technique to fuse multi-source fatality data in real time, calculate the number of fatalities in the affected area at current time, and predict the number of relief-demands. Its expression can be denoted by formula (8.2).

$$D_i(t) = \alpha \times S_i(t) \times \overline{L} + z_{1-\alpha} \times VAR_i(t) \times \sqrt{\overline{L}} \quad (8.2)$$

In formula (8.2), $D_i(t)$ represents the instantaneous relief-demand of the affected area. *a* is a parameter representing the average hourly relief demand needed per survival in the affected area. $\overline{L}$ is the upper bound of the tolerable lead time for relief distribution to any given affected area. And the parameter α should meet the equation as follows.

$$Prob\left(\overline{L} \leq D_i(t)\right) = 1 - \alpha \quad (8.3)$$

In addition, $S_i(t)$ represents the instantaneous amount of relief-demand needed by the trapped survivals in affected area. It can be noted by:

$$S_i(t) = \delta_i - X_i(t) \tag{8.4}$$

where, δ_i represents the existing population of affected area, which is assumed to be available in advance from the socio-economic database of the corresponding local government. The accumulated number of fatalities associated with a given affected area is denoted by $X_i(t)$. This variable is related with the uncertainty level of information source in the given affected area. That is to say, $X_i(t)$ is related with $H(t)$ representing information entropy. It is can be denoted by:

$$H(t) = -\sum_{m-1}^{M} P(m|x(t)\log\left[p\left(m|x(t)\right)\right] \tag{8.5}$$

VAR $(t)_i$ represents the temporal variability of relief demand, which is given by:

$$VAR_i(t)\sqrt{\frac{\sum_{\varepsilon-0}^{t-1}\left[D_i(t-\varepsilon)-\bar{D}_i(t)\right]^2}{t}} \tag{8.6}$$

8.3.2.2.3 Relief Demand Forecasting Based on Safety Stock Theory

Professor Sheu from National Chiao Tung University in Taiwan [11] assumed that the time-varying relief demand needed in a given affected area is highly correlated with the number of corresponding local survivals, with similar conclusions being drawn in the literature [10]. This paper treated daily-consuming relief and daily-used equipment as its object. According to the characteristics of the relief efforts, the relief-demand forecasting method after emergency can be given respectively. Thus in terms of daily consuming relief, the demand amount includes two parts—safety stock and the real demand of survivals—which is given by

$$D_i(t) = \max\left\{\alpha \times \delta_t(t) \times STD_i(t) \times \sqrt{\bar{L}}, 0\right\} \tag{8.7}$$

And, in terms of daily-used equipment, the demand amount of this relief considers three parts, which can be denoted by:

$$D_i(t) = \max\{\alpha \times \delta_i(t) + b_i - C, 0\} \quad (8.8)$$

For formula (7) and (8), parameter *a*, $\overline{L}$ and α has the same meaning with formula (2). And $\delta_i(t)$ represents the estimated number of survivals trapped in an affected area in a given time interval *t*. The corresponding buffer demand or safety stock associated with this relief is denoted by b_i. *C* represents the accumulated time-varying amount of relief arriving at the affected area in a given time interval *t*. The time-varying standard deviation of relief demand associated with the affected area is denoted by $STD(t)_i$.

All the methods of relief-demand forecasting mentioned above were all applied more or less to the process of relief distribution in some real cases, such as the massive earthquake that measured 7.3 on the Richter scale, which occurred in central Taiwan, the southern big snowstorm and the Wenchuan earthquake that happened in 2008 in China, and the 8.2 magnitude earthquake that occurred in Chile in 2014, and so on.

8.4 CONCLUSIONS

For a variety of emergencies, the phenomena that is supply-demand imbalance and relief distribution delay in the emergency logistic system have attracted more attention from various professionals. For this problem, enhancing the relief-demand forecasting accuracy is an effective solution. Fundamentally, the forecasting accuracy is highly correlated with relief classification, the characteristics of relief-demand in the affected area, and the selection of a relief-demand forecasting method.

In this paper, we analyze and summarize the relief-demand forecasting problem in the emergency logistic system based on the main premise that relief classification—the analysis of demand characteristics—is the best relief-demand forecasting method. This paper makes a conclusion as follows:

1. Identifying the relief classification and the characteristics of relief-demand in the affected area is the basis and prerequisite of relief-demand forecasting in an emergency logistic system.
2. The proper and reasonable forecasting method selected is an effective way of avoiding the phenomenon that supply-demand imbalance and relief distribution delay.

3. The relief-demand forecasting that demand method develops from is based on experience or expert judgment towards quantitative, information technology and intelligence.

Above all, during the era of rapid development of information technology, cloud computing and big data bring relief-demand forecasting not only challenges but also opportunities.

REFERENCES

1. Sun, B.Z., Ma, W.M. and Zhao, H.Y. (2013) A Fuzzy Rough Set Approach to Emergency Material Demand Prediction over Two Universes. Applied Mathematical Modelling, 37, 7062-7070. http://dx.doi.org/10.1016/j.apm.2013.02.008
2. Wilson, D.T., Hawe, G.I., Coates, G. and Crouch, R.S. (2013) A Multi-Objective Combinatorial Model of Casualty Processing in Major Incident Response. European Journal of Operational Research, 230, 643-655. http://dx.doi.org/10.1016/j.ejor.2013.04.040
3. Xu, X.Y., Qi, Y.Q. and Hua, Z.S. (2010) Forecasting Demand of Commodities after Natural Disasters. Expert Systems with Applications, 37, 4313-4317. http://dx.doi.org/10.1016/j.eswa.2009.11.069
4. Jones, S.S., Evans, R.S., Allen, T.L., et al. (2009) A Multivariate Time Series Approach to Modeling and Forecasting Demand in the Emergency Department. Journal of Biomedical Informatics, 42, 123-139. http://dx.doi.org/10.1016/j.jbi.2008.05.003
5. Ninno, C.D., Dorosh, P.A. and Smith, L.C. (2003) Public Policy, Markets and Household Coping Strategies in Bangladesh: Avoiding a Food Security Crisis Following the 1998 Flood. World Development, 31, 1221-1238. http://dx.doi.org/10.1016/S0305-750X(03)00071-8
6. Liu, W.M., Hu, G.Y. and Li, J.F. (2012) Emergency Resources Demand Prediction Using Case-Based Reasoning. Safety Science, 50, 530-534. http://dx.doi.org/10.1016/j.ssci.2011.11.007
7. Wang, W. and Liu, M. (2010) Method of Emergency Resources Demand Forecasting Based on Case-Based Reasoning. Journal of Safety and Environment, 10, 217-220.
8. Deng, S.C., Wu, Q., Shi, B., et al. (2014) Prediction of Resource for Responding Waterway Transportation Emergency Based on Case-Based Reasoning. China Safety Science Journal, 24, 79-84.
9. Wang, X. and Zhuang, Y. (2010) Forecasting Model of Unconventional Emergence Incident's Resource Demand Based on Case-Based Reasoning. Journal of Xidian University (Social Science Edition), 20, 22-26.
10. Sheu, J.B. (2010) Dynamic Relief-Demand Management for Emergency Logistics Operations under Large-Scale Disasters. Transportation Research Part E: Logistics and Transportation Reviews, 46, 1-17. http://dx.doi.org/10.1016/j.tre.2009.07.005
11. Sheu, J.B. (2007) An Emergency Logistics Distribution Approach for in Disasters. Transportation Research Part E: Logistics and Transportation Reviews, 43, 687-709. http://dx.doi.org/10.1016/j.tre.2006.04.004

12. Fiedrich, F., Gehbauer, F. and Rickers, U. (2000) Optimized Resource Allocation for Emergency Response after Earthquake Disasters. Safety Science, 35, 41-57.
13. Qin, J.C., Xing, Y.T., Wang, S., et al. (2012) An Inter-Temporal Resource Emergency Management Model. Computers & Operations Research, 39, 1909-1918. http://dx.doi.org/10.1016/j.cor.2011.07.008
14. Li, C.D., Cao, C.J. Yang, Q., et al. (2014) Application of BOX theory in Multi-Stage Emergency Resource Scheduling-Taking Emergency Response Stage as an Example. China Safety Science Journal, 24, 159-165.
15. Roger, C.S. and David, B.L. (1989) Creativity and Learning in a Case-Based Explainer. Artificial Intelligence, 40, 353-385. http://dx.doi.org/10.1016/0004-3702(89)90053-2

CHAPTER 9

Can Merging the Roles of Public Health Preparedness and Emergency Management Increase the Efficiency and Effectiveness of Emergency Planning and Response?

Nadja A. Vielot and Jennifer A. Horney

9.1 INTRODUCTION

In the wake of disasters, various public health, emergency response, and government agencies must work together to implement preparedness plans and mount an effective response that may include activities as varied as opening and operating shelters, rapidly assessing unmet needs for utilities and other essential services, and providing services such as debris removal to residents. Since 2002, federal funding for public health preparedness has been provided by the Centers for Disease Control and Prevention (CDC) to state, local, tribal, and territorial public health departments through the Public Health Emergency

Preparedness (PHEP) cooperative agreement. PHEP cooperative agreements are the main source of funding local health departments (LHDs) use to develop and maintain their ability to effectively respond to public health threats, including infectious diseases, natural disasters, and biological, chemical, nuclear, and radiological events [1]. Many states have used PHEP funds to fund positions for public health preparedness coordinators (PCs). These PCs lead the LHD's efforts related to planning, exercising, and working with partners and volunteers that are necessary to improve the capacity of LHDs to plan for, respond to, and recover from public health emergencies.

In recent years, PHEP funding has declined significantly. From fiscal years 2005–2012, federal preparedness funds to state and local health departments from CDC were reduced more than 38% (adjusted for inflation) [2] Economic surveillance surveys conducted by the National Association of County and City Health Officials (NACCHO) from 2008–2011 found that many LHDs have experienced budget cuts, loss of staff, and service reductions [3]. In 2011, 23% of LHDs surveyed by NACCHO reported that they had reduced or eliminated their emergency preparedness program, making it the program area, along with clinical health services, most frequently cut [3]. At the same time, the economic recession has negatively impacted funding for emergency management. The National Emergency Management Association estimates that more than a dozen states have eliminated positions in emergency management or furloughed employees, negatively affecting planning, training, and exercises [4]. Perhaps more critically, nearly 60% of states report difficulties in meeting the 50% match required for their state to receive funding from the Emergency Management Performance Grant, the only source of federal money directed to state and local governments for planning, training, exercises, and personnel for all-hazards emergency preparedness [4].

Historically, emergency managers have operated under the "command and control" paradigm, in which response activities were mandated by governments and executed by local law enforcement, fire departments, and emergency medical services [5,6]. Emergency managers were tasked with coordinating emergency operations of various responders, ensuring communications, and providing linkages to policy makers [7]. More recently, emergency management has effectively transitioned to a focus on all hazards and comprehensive emergency management, which includes natural and technological disasters, as well as public health emergencies such as intentional events (e.g., the anthrax attacks of 2001) and naturally occurring pandemics (e.g., the 2009 novel influenza A (H1N1) pandemic). For example, principles for emergency management developed after

the failed response to Hurricane Katrina in 2005 call for progressive, integrated, collaborative, coordinated, and flexible emergency managers [8]. In addition, the threat of bioterrorism has led to a greater appreciation of the importance of public health as first responders, and has increased coordination between public health and emergency response. Because public health organizations are well-engaged with their communities and are skilled in communications and outreach, disaster preparedness and response may be improved by combining the resources of public health with those of emergency management. As a result, emergency management and public health preparedness agencies and officials have increasingly been able to collaborate to develop emergency response protocols and promote community resilience [9].

In recent years, given the reduced threat of bioterrorism and increased threat of emerging infectious diseases (e.g., the 2009 novel influenza A (H1N1) pandemic), the importance of public health in emergency response has earned greater recognition and efforts to bridge the divide between emergency management and public health preparedness have increased. A schism still exists, however, between the two disciplines. Next steps in nurturing this relationship include the clarification of roles and responsibilities between county governments and health departments, and the development of preparedness plans that are clear, actionable, and proven through table-top exercises and simulations [10].

In light of recent budget cuts to LHDs and emergency management, some counties have been forced to reduce their workforce and reallocate responsibilities related to emergency preparedness and response. In six North Carolina counties, the role of public health preparedness coordinator has been merged with emergency management, emergency medical services, or hospital emergency management. To our knowledge, this experience is unique to these counties, and it is unclear how well this arrangement will affect emergency preparedness and response. To better understand the impact of combining these workforce assets in North Carolina, a study aimed at describing the roles and responsibilities of these merged positions was carried out by the North Carolina Preparedness and Emergency Response Research Center (NC PERRC) at the University of North Carolina at Chapel Hill Gillings School of Global Public Health.

9.2 EXPERIMENTAL SECTION

Interviews were conducted with individuals performing roles that covered shared responsibilities in emergency management, emergency medical services,

hospital preparedness, and public health preparedness. Three initial key informants (KIs) were identified through informal communication between the research team and attendees at the N.C. Division of Public Health's Office of Public Health Preparedness and Response annual Preparedness Coordinator conference. Individuals initially contacted for interviews were then asked to identify others who might be working in the same or a similar capacity. Individuals were considered eligible to participate in the study if they reported having regular job responsibilities that included both emergency management, emergency medical services, or hospital-based emergency manager and public health preparedness coordination; represented a county of the state of North Carolina; and were based in a county government office, a county health department, or a county hospital system.

Semi-structured phone interviews were conducted by a pair of interviewers with six KIs from the following counties in North Carolina: Columbus, New Hanover, Orange, Stokes, Wilson, and Yadkin (Figure 9.1). The interview guide was adapted from one used in a previous NC PERRC research project examining the structural capacity of Public Health Regional Surveillance Teams [11]. It included open-ended questions regarding the nature of the position in each county, the KIs opinions on the usefulness of the shared position, and their recommendations for implementing it in other counties. Closed ended questions asked KIs to identify key partners and resources among an exhaustive list of potential preparedness and emergency management partners. Where warranted, KIs were asked to provide examples of their experiences working under

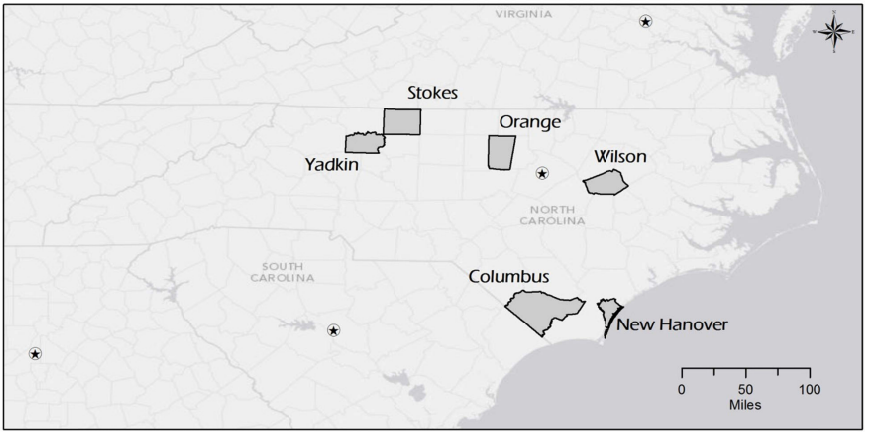

FIGURE 9.1 Map of Columbus, New Hanover, Orange, Stokes, Wilson, and Yadkin Counties, North Carolina, USA

the new model during actual emergency responses or exercises to provide case study examples to inform other counties potentially interested in combining these positions in the future.

Interviews were recorded, transcribed, and analyzed to identify major themes. Each interview lasted between 30–60 min. Quotations that succinctly illustrated the perspective of a given KI were extracted and reprinted in the Results section. KIs are not identified by name, but by the county in which they are employed. The project was reviewed and determined exempt by the University of North Carolina at Chapel Hill Institutional Review Board (#14-0332).

9.3 RESULTS AND DISCUSSION

9.3.1 Qualifications for Serving in Both the Emergency Management and Public Health Preparedness Capacities

Because the combined emergency management and public health preparedness coordinator position is relatively new, few formal requirements for the position were reported. Two KIs reported that Incident Command System (ICS) certification was required of applicants during the recruitment phase. Most respondents reported having a background in emergency management or emergency medical services; some had served as paramedics and firefighters in previous positions. No counties reported that public health credentials were required, though one reported that a registered nurse (RN) was preferred, but not required, for the position.

9.3.2 Division of Responsibilities

In no case were the KIs' responsibilities for emergency management and public health preparedness divided evenly. KIs from two counties reported that the majority of their time was devoted to emergency medical services and emergency management respectively, while those from two other counties reported that most of their time was dedicated to public health. Tasks and priorities differed depending on where KIs' directives come from: emergency management or the local health department. The supervisory arrangements and scopes of work differed by county, depending on the unique needs of each:

> "There's been a large turnover in PC's (Public Health Preparedness Coordinator) since I started in April (2013). And I've noticed that there are not a lot of defined roles for a PC across the state. A lot of other stuff gets blurred in."

Most KIs reported that their responsibilities within each domain, if not across domains, are clearly defined. This is primarily a result of good communication and strong coordination between the local health department and county emergency services.

9.3.3 Routine Collaborations with Other Public Health and Emergency Services Agencies

In order to fulfill their dual roles, KIs consistently reported collaborating with the county health director, emergency management director, local law enforcement, fire department, emergency medical services, other emergency response partners, and regional hospitals. Some KIs are actually hospital-based emergency managers, and similarly report collaborations with the local health department and emergency management services:

> "You name it, we work with them. It's to the point where I have a key to the health department and 24 h access. We're in constant contact."

All counties have meetings at least quarterly with some or all of their collaborators. Most report quarterly meetings with their Local Emergency Planning Committees (LEPCs), with additional monthly meetings among local state and preparedness partners as deemed necessary. See Appendix Table 9.A1 for a list of partner organizations and resources identified by each KI.

9.3.4 Perceived Motivations for Merging the Positions

Different counties had different motivations for the merger. KIs from two counties reported that the merger was a matter of convenience and efficiency. The overlapping responsibilities between emergency management and public health preparedness, with respect to developing preparedness and response plans and conducting training exercises, were conducive to a shared role. The KI from 1 county reported that the need to develop a pandemic influenza plan in 2006

required an additional staff member, and he was hired to help bridge the gap between public health and emergency management to help write the plan. Another KI also reported that the small size of the county made it a good candidate for the dual role. In these two counties, the position was conceived and developed around the specific skill sets of the people recruited for the position.

In two other counties, however, the merger was necessary. The KI from one county reported a lack of funding in the health department to hire a full-time preparedness coordinator position. The KI from another county reported the need for a full-time employee to serve the county and manage the emergency management and public health preparedness coordinator responsibilities. Prior to the merger, the emergency management and public health preparedness coordinator positions were each only half-time positions.

9.3.5 Ability to Carry Out Responsibilities in the Emergency Management and Public Health Preparedness Domains

Most KIs reported feeling sufficiently knowledgeable to be able to perform both emergency management and public health preparedness roles. This was a result of strong linkages in both domains that allowed them to consult with other public health or emergency management staff to fill knowledge gaps. The KIs from two counties reported wanting more training in public health substantive areas, specifically epidemiology and environmental health, to help them approach public health preparedness topics more effectively. KIs in two other counties reported having a firm grasp on the basics, but would like more training in the nuances of both emergency management and public health preparedness. Because the position is new, standard job requirements and scopes of work have not yet been developed for use across counties. As a result, individuals in this position are often learning on the job:

> "It would be a learning process for anybody. There isn't any school or any class or any one thing that would really prepare you for this position. I knew about PODs (Points of Dispensing) from my emergency management background. But we didn't have any training on what a POD was, how to operate a POD, what the parts of the POD were. All we were told is when they bring you down here and they hand you all this medicine you're supposed to dispense it. So I took the POD class and it made everything clearer.... (But) I am still learning this whole LTAR (Local Technical Assistance Review) thing."

The KI from one county similarly reported that the training exercises in PODs and other topics were helpful to them; however, budget cuts in the last couple years have made it so that many of those new to these positions will not receive critical training. All KIs reported being well-supported in fulfilling their duties in both the emergency management and public health preparedness domains by their supervisors, coworkers, and external partners. Strong linkages and positive relationships between the public health and emergency management departments ensure that individuals in the new position have the time, resources, and training to complete their duties in both capacities.

9.3.6 State of Public Health Preparedness

Most KIs reported that their emergency preparedness plans were better than they were prior to the merger, or at least will become better in the long run. This is due primarily to the merging and streamlining of public health preparedness and emergency management plans, which recognizes the extensive overlaps between them. The plans are now more cohesive and concise and more easily accessible to a variety of users:

> "Needless to say, if you've got 40 hours to devote (to preparedness) rather than 20, you're able to do more."

One KI expressed doubts that plans would necessarily improve in a county with a larger population (i.e., greater than 200,000), where there may not be sufficient expertise in both subject areas to be able to write preparedness plans to cover such a large jurisdiction. The counties included in this case study who had implemented the shared public health and emergency management, emergency medical services, or hospital preparedness positions had an average population of 71,000 (Range: 38,000–133,000).

9.3.7 Barriers to Implementation of the Merged Position

Each KI identified unique challenges in their jurisdiction to the effective implementation of the merged emergency management and public health preparedness coordinator position. One county reported that funding for salaries and supplies is split between the emergency management and public health

preparedness budgets, and that it is sometimes difficult to prioritize spending for supplies and resources that are critical for emergency management. Another county reported that funding for public health is much more restricted and limited than for emergency management, and that the requirements to receive public health preparedness funding from the CDC are more stringent. In the opinion of some KIs, the time spent fulfilling these requirements may not worth the sum of money received:

> "Public health is very specific on what you can spend your funds on. They would buy things that I don't know would benefit us."

One KI reported that their county has not experienced any major emergencies recently. The KI worried that the resulting complacency might make it harder to prepare for and respond to emergencies. Without the threat of an emergency, there is less pressure or incentive to focus on preparedness:

> "The biggest barrier is, knock on wood, we haven't had much in the way of disaster related events. After 9/11 people got saturated with it for a while, but people have gotten a little more complacent."

One KI described a large gap between public health and emergency management at the state level, in which the N.C. Division of Public Health may not reach out to N.C. Emergency Management for support, meaning that a lot of efforts are duplicated. These communication issues may negatively affect operations at the local level if state agencies request duplicative deliverables:

> "Public health should not be requiring our auxiliary communications folks to prove that they test their systems on a regular basis. Doing the job is not a problem, satisfying the needs of somebody else in (Washington, DC) or Raleigh (N.C.) is the problem."

Another KI did not report personal barriers, but speculated that uneven funding and timing split between the emergency management and public health preparedness domains may pose challenges in counties that are more siloed and have a hard time coordinating efforts across departments. One or the other domain will receive less support.

9.4 CONCLUSIONS

In the six counties in North Carolina in which this model has been implemented, it has contributed to the improved quality of public health preparedness and emergency operations plans and streamlined processes related to both emergency management and public health preparedness. It has also helped to cut costs and eliminate redundancy of responsibilities. Remaining challenges include dividing funding and responsibilities for each domain appropriately to ensure that neither side is neglected. Overall, the model appears to function well in a variety of counties in North Carolina, and all the KIs included in this study would recommend the model of the shared emergency management and public health preparedness position for other counties, provided that they meet the following conditions:

- The county must be small enough for the responsibilities of emergency management and public health preparedness to be fulfilled by one person;
- The individual in the role has sufficient expertise in emergency management and public health to be able to perform effectively;
- The county emergency management and public health departments are working towards the same goals, and;
- Funding for the role is split evenly between emergency management and public health preparedness to ensure that both domains are given equal priority.

This study has several limitations. As an exploratory case study with a very small sample size, findings cannot be generalized beyond the counties that participated. Additional research and evaluation studies are needed in order to confirm KI perceptions. Future research could include objective comparisons of the quality of plans written in a jurisdiction where these positions had been merged with one where they had not been merged or observing and evaluating exercises or emergency responses in jurisdictions with both merged and unmerged positions.

REFERENCES

1. CDC. HHS Funds Strengthen National Health Security; CDC: Atlanta, GA, USA, 2013.
2. Levi, J.; Segal, L.M.; Leiberman, D.A.; May, K.; Lang, A.; St. Laurent, R. Ready or Not? Protecting the Public's Health From Diseases, Disasters, and Bioterrorism; Trust for America's Health: Washington, DC, USA, 2012.

3. NAACHO. Local Health Department Job Losses and Program. Cuts : Findings from the January 2012 Survey; National Association of County & City Health Officials: Washington, DC, USA, 2012.
4. Bell, B. Recession Hits Emergency Management. Available online: http://www.csg.org/pubs/capitolideas/ enews/issue23_3.aspx (accessed on 4 February 2014).
5. Choi, S.O. Emergency management: Implications from a strategic management perspective. J. Homeland Secur. Emerg. Manage. 2008, 5, 1–21.
6. Waugh, W.L., Jr.; Streib, G. Collaboration and leadership for effective emergency management. Public Adm. Rev. 2006, 66, S131–S140.
7. Drabek, T.E. The Professional Emergency Manager; Institute of Behavioral Science, University of Colorodo: Boulder, CO, USA, 1987.
8. Principles of Emergency Management Supplement. Available online: http://www.ndsu.edu/fileadmin/emgt/PrinciplesofEmergencyManagement.pdf (accessed on 3 March 2014).
9. Barishansky, R.M.; Mazurek, A. Public health's role in understanding community resilience. J. Homel. Secur. Emerg. Manag. 2012, 9, 1–5.
10. Kahn, L.H. Who's in Charge? Leadership During Epidemics, Bioterror Attacks, and Other Public Health Crises; Greenwood Publishing Group: Santa Barbara, CA, USA, 2009; p. 236.
11. Horney, J.A.; Markiewicz, M.; Meyer, A.M.; Casani, J.; Hegle, J.; Macdonald, P.D. Regional public health preparedness teams in North Carolina: An analysis of their structural capacity and impact on services provided. Am. J. Disaster Med. 2011, 6, 107–117.

APPENDIX

TABLE 9.A1 Partnerships and collaborations with local agencies reported by key informants.

Agency	Partner*	Resource†	Neither‡
Local health department director	5	0	1
Local health department staff	6	0	0
Regional offices of the N.C. Office of Public Health Preparedness and Response	5	1	0
Regional hospital-based Public Health Epidemiologists	3	3	0
Office of Public Health Preparedness at the N.C. Division of Public Health	3	3	0
Office of Occupational Epidemiology at the N.C. Division of Public Health	2	4	0
Communicable Disease Branch at the N.C. Division of Public Health	4	2	0
N.C. State Public Health Laboratory	2	4	0
N.C. Department of Environment and Natural Resources	1	4	1
N.C. Department of Agriculture and Consumer Services	2	3	1
Local Office of Emergency Management	6	0	0
N.C. Emergency Management Regional Offices	4	2	0
N.C. Office of Emergency Management	4	2	0
Hazardous Materials Regional Response Teams	2	4	0
State Medical Assistance Teams	5	1	0
Domestic Preparedness Readiness Regional Committees	4	2	0
Local Health Information Teams	2	1	3
Cities Readiness Initiative	0	1	5
Local Emergency Planning Committees	4	1	1
Medical Reserve Corps	3	0	3
State Animal Response Teams	1	2	3
N.C. Veterinary Response Corps	1	3	2
Intrastate Crisis Communication Enhancement Network	1	4	1
Search and Rescue Task Force Teams	1	4	1
Local Emergency Medical Services	6	0	0
Emergency Medical Services Regional Advisory Committee	5	0	1
N.C. Office Emergency Medical Services	3	2	1
Local or regional hospitals and healthcare providers	6	0	0
Hospital infection control nurses	5	0	1

TABLE 9.A1 *(Continued)*

Agency	Partner*	Resource†	Neither‡
Hospital safety officers	3	1	2
Local or state law enforcement	6	0	0
Local fire services	5	1	0
Military preparedness organizations	1	1	4
School safety coordinators	3	1	2
School administration	5	1	0
Correctional facilities	0	1	5
U.S. or State Forest Service	3	2	1
Airport or customs officers	1	1	4
N.C. Ports	1	0	5
County commissioners	5	0	1
Department of Veterans Affairs	2	2	2
American Red Cross	6	0	0
Social work agencies	5	1	0
Mental health and substance abuse agencies	2	2	2
Religious organizations	2	4	0
Academic institutions	4	2	0
Private businesses	4	2	0

Notes: *Partner: An agency with whom the KI worked regularly to carry out job duties. †Resource: An agency on whom the KI could rely for information or assistance with a project, but with no formal relationship. ‡Neither: An agency that either does not exist in the KI's county, or with which he or she did not associate.

PART V
Educating Medical Staff to Handle Disasters

CHAPTER 10

Optimizing Global Health Experiences in Emergency Medicine Residency Programs: A Consensus Statement from the Council of Emergency Medicine Residency Directors

Janis P. Tupesis, Christine Babcock, Doug Char, Kumar Alagappan, Braden Hexom, and G. Bobby Kapur

10.1 BACKGROUND

Over the past 20 years, interest in global health opportunities among medical students and residents has been increasing. In 2001, 20% of graduating medical students stated that they had participated in an international/global health training experience during medical school, up from 5% in 1984 [1,2]. In 2011, this number had increased to 30.5% [3]. Experiences from various graduate medical education programs seem to indicate that participating in a global health elective during training exposes trainees to different disease pathologies, teaches them to work in resource limited settings, increases their cultural sensitivity and

communication skills, and provides them with an increased awareness of community and public health [4-10]. However, despite the increased interest by resident trainees, little has been done in the standardization of these experiences. Often, residency program directors are charged with identifying the educational merit of global health electives without having first hand knowledge of the experience. Without standardization, large disparities remain in funding, accreditation, oversight and evaluation among EM residency training programs.

10.2 METHODS

Each year, CORD convenes program directors, clerkship directors, administrators and other educators at its annual Academic Assembly (AA). As part of the 2011 AA, a specialty track was devoted to evaluate how global health experiences are integrated into EM residency training programs. Two months prior to the conference, all EM residency programs in the US were asked to fill out an online survey (Surveymonkey, Palo Alto, CA) querying individual program practices regarding resident global health electives. The survey consisted of nine questions and can be seen in Table 10.1 below. Survey participants were identified by CORD's email listserve, representing all residency training programs in the US. A follow-up email was sent through the same listserve 2 weeks prior to the conference.

During the 2011 AA, approximately 40 residency program directors (PD), associate/assistant program directors (APD), EM faculty members and program coordinators participated in the specialty track: International Emergency Medicine Electives – Practical Application and Implementation in a Residency Training Curriculum. The specialty track was divided into three 1-h sessions, each focused on a different aspect of global health in Graduate Medical Education. The focus of the first 2 h was on the "pre-departure" preparatory time frame for both residents and program directors. During this session, the panel discussed regulatory stances by the American Board of Emergency Medicine (ABEM), the Accreditation Council for Graduate Medical Education (ACGME) and the Residency Review Committee (RRC) and the implications of these stances for institutional and individual funding. This was followed by a discussion of the optimization of global health "elective" documentation, both from a programmatic (PD) and institutional (Designated Institutional Official) perspective, using materials supplied from the GME office at the University of Wisconsin. Specific topics included: international site evaluations, emergency plans and

procedures, program director/mentor letter of endorsements, pre-departure cultural competency curricula, professionalism agreements, blood-borne pathogen protocols and post-elective resident/site/experience evaluations.

TABLE 10.1 Results from global health experiences survey of Council of Emergency Medicine Residency Directors

Question	Yes	No
1. Do you currently have global health partnerships and global health electives available for residents?	30 (71.4%)	12 (28.6%)
If responded "yes" to question 1: ($n = 30$)		
2a. Does your GME office require a formal application for global health electives?	26 (65%)	4 (35%)
2b. If so, does it require an evaluation of the international training site?	15 (57.7%)	11 (42.3%)
3. Does it require a faculty mentor?	27 (90%)	3 (10%)
4. Does it require a professionalism agreement?	16 (53.3%)	14 (46.7%)
5. Does your GME office fund residents' stipends during GH electives?	24 (80.0%)	6 (20.0%)
6. Do you have formal pre-departure training for residents that participate in global health electives?	11 (36.7%)	19 (63.3%)
7. Do you provide a post-elective feedback/debriefing session?	20 (66.7%)	10 (33.3%)
8. Do you have a formal competency requirement for residents that elect to participate in global health electives?	6 (20.0%)	24 (80.0%)

The last part of the specialty track was focused on protocols to optimize EM global health electives for residents. The discussion focused on methods to evaluate these electives prior to the residents' departure, methods to standardize the evaluative process for residents while on these electives and methods to debrief/evaluate residents upon their arrival back home. One of the main discussion points focused on how to evaluate international training sites for residents in order for the elective to be more effective. It was noted that PDs need a systematic way to evaluate the maturity of EM in a country. Participants noted the challenge of identifying clinical sites that offer sound educational opportunities for the residents—not only ones that are based on geography, safety, logistics and support. At the end of these sessions a working group was convened in order to discuss survey results, give feedback on the session and offer creative solutions to some of the challenges outlined. Members of this working group included Emergency Medicine residency program directors and associate

program directors, Emergency Medicine residency program coordinators and academic faculty involved in institutional global health programs. The primary areas of initial focus were the application process for residents to apply for electives, evaluations methods of the electives and areas for partnership.

10.3 RESULTS AND DISCUSSION

Responses were received from 42 of 155 residency training programs, with a response rate of 27% (Table 11.1).

The following is a review of the general recommendations from the working group and general sessions:

10.3.1 Application

1. Global Health Elective Application Standardization: It is recommended that global health elective application materials be standardized. During the consensus proceedings, many of the participants offered to "open source" application materials for other programs to use. It was proposed that the CORD "Sharepoint" website could be used for this in order for the entire organization's constituency to be able to access these materials.
2. Global Health Elective Application Availability: It is recommended that the global health application materials be made available to individual institutional GME offices, PDs and resident applicants. As above, training programs that have developed "best practices" were encouraged to share their application materials. It is encouraged that these materials be used as they provide a concise, organized and thorough approach for institutional officials to use.

10.3.2 Evaluation

1. Global Health Site Evaluation: In order to provide the most robust educational experience for the resident trainees and ensure long-term evaluation of site value, it is recommended that a standardized metric or tool be developed to evaluate international training sites. Specifics proposed to be used in this tool included: identifying mentor/supervisor at training site,

identifying type of experience (clinical, research, public health), identifying agreed-upon roles and responsibilities for the resident, assuring adequate pre-departure logistics training for the resident (housing, transportation, food, security, immunizations, travel vaccines, travel medication, evacuation insurance, etc.).

2. Resident Evaluation: In order to derive optimal data from these experiences and to provide PDs with essential feedback for monitoring core competency development, it is proposed that a standardized resident clinical evaluation tool be developed. It was proposed that a standardized evaluation of the resident and a standardized resident evaluation of the training site be developed. The resident evaluation was to be a competency-based evaluation, based on the Accreditation Council of Graduate Medical Education's paradigms of Patient Care, Medical Knowledge, Practice-Based Learning, Interpersonal and Communication Skills, Professionalism and Systems-Based Practice. It was proposed that resident evaluations of the program include: overall educational value of the experience, ease of arranging the elective, level of supervision provided, level of service/support provided, value to career growth and value for personal development.

10.3.3 Partnership

1. Global Health Site Database: It is recommended to continue to work with other professional organizations (EMRA, SAEM Academy, ACEP, AAEM) and their International Interest groups to provide a comprehensive, real-time clearinghouse of global health opportunities. At the time of the conference, there was an active project by members of the Emergency Medicine Residents Association (EMRA) to collate and publish this data.
2. Global Health Mentoring: In order to foster long-term investment in global health skills development and career mentorship, it is recommended that a virtual mentoring program be developed for residents and faculty at those sites that have limited opportunities.
3. Strategic Planning: It is recommended that a Global Health Education Working Group be developed within CORD to improve and integrate the process by which educational electives are offered and evaluated and promote the standardization with which resident trainees are assessed.

10.4 DISCUSSION

Interest in global health education among medical students, residents, faculty and institutions continues to increase [11-13]. However, the evaluation of a truly "educational" elective and the standardization of applications, funding structures, site and resident evaluations remain elusive. While over 70% of respondent residency programs offer elective opportunities in global health, a third or less have formal competency evaluation for residents prior to participating (20%) and a formalized pre-departure training process (36.7%). Similarly, programs often do not have standardized methods to evaluate the training sites where the residents will be doing their clinical work, and frequently the residents themselves.

A wealth of data, both during medical school and residency training, shows that students and physicians in training find participation in a global health elective to be a valuable experience. They describe enhanced clinical and communication skills, exposure to different disease processes, increased cultural sensitivity, attention to appropriate resource allocation and enhanced community, social and public health awareness. Many of these skill sets are analogous to the ACGME core competencies used to evaluate trainees. However, a paucity of data evaluating resident experiences in these environments persists.

While many other professional organizations in EM have international/global health sections, CORD does not. Given the increasing interest among residents, the poor standardization of processes and the possibility of marked impact on resident education, the working group suggests creating a Global Health Working Group within CORD. In doing so, this resource may decrease the administrative time needed for PDs to offer a robust educational experience, offer guidance to PDs that have limited global health experience/exposure and help navigate the complexities of institutional GME oversight.

10.5 CONCLUSIONS

During the 2011 CORD Academic Assembly, a Specialty Track in Global Health training was convened and participants discussed guidelines and best practices for global health training beneficial to the membership of CORD. The Specialty Track developed the following consensus recommendations to enhance the global health education of emergency medicine residents:

- Create a Global Health Working Group within CORD
- Work with other professional organizations within EM to provide a well-organized, up-to-date clearinghouse of global health opportunities for residents
- Standardize global health application materials; make these available to EM program directors
- Standardize resident evaluations during global health rotations; make these available to EM program directors

REFERENCES

1. AAMC: Medical School Graduation Questionnaire. Washington DC: Association of American Medical Colleges; 1984.
2. AAMC: Medical School Graduation Questionnaire. Washington DC: Association of American Medical Colleges; 2001.
3. AAMC: Medical School Graduation Questionnaire. Washington DC: Association of American Medical Colleges; 2011.
4. Haq C, Rothernberg D, Gjerde C, Bobula J, Wilson C, Bickley L, Cardelle A, Joseph A: New world views: preparing physicians in training for global health world. Fam Med 2000, 32(8):566–572.
5. Ramsey AH, Haq C, Gjerde C, Rothenberg D: Career influence of and international experience during medical school. Fam Med 2004, 36 (6):412–416.
6. Jeffrey J, Dumont R, Kim G, Kuo T: Effects of international health electives on medical student learning and career choice: results of a systemic literature review. Fam Med 2011, 43(1):21–28.
7. Lee A, Newby PK, Chamberlin MR, Huang C: Global health training in pediatric residency programs. Pediatrics 2008, 122(1):28–33.
8. Bauer T, Sanders J: Needs assessment of Wisconsin primary care residents and faculty regarding interest in global health training. BMC Med Educ 2009, 9:36.
9. Sawatsky A, Rosenman D, Merry S, McDonald F: Eight years of the may international health program: what an international elective adds to resident education. May Clin Proc 2010, 85(8):734–741.
10. Bazemore A, Henein M, Goldenhar L, Szaflaski M, Lindsell CJ, Diller P: The effect of offering international health training opportunities on family medicine residency recruiting. Fam Med 2007, 39(4):255–260.
11. Kirsch TD, Holliman CJ, Hirshon JM, Doezema D: The development of international emergency medicine: the role of United States emergency physicians and organizations. Acad Emerg Med 1997, 4(10):996–1001.
12. Arnold JL: International emergency medicine and the recent development of emergency medicine worldwide. Ann Emerg Med 1999, 33:97–103.
13. Alagappan K, Holliman CJ: History of the development of international emergency medicine. Emerg Med Clin North Am 2005, 23(1):1–10.

CHAPTER 11

Preparation of Medical Personnel for an Early Response Humanitarian Mission—Lessons Learned from the Israeli Defense Forces Field Hospital in the Philippines

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11.1 BACKGROUND

Unfortunately, natural disasters occur throughout history and at times cause mass casualties which warrant the rapid deployment of medical response aid missions to overcome the damage [1-3]. In November 2013, tropical cyclone Haiyan (Yolanda) slammed the Philippines archipelago, leaving more than an estimated 6000 dead in its wake while demolishing vital infrastructure and affecting the life of an estimated 25 million locals [4]. In the storms' aftermath welfare infrastructures were severely damaged and capabilities of local healthcare services dramatically decreased. As in other massive natural disasters, the Israeli Government instructed the Israeli Defense Forces (IDF) to rapidly construct a

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humanitarian aid delegation which included a field hospital deployment with medical capabilities from diverse specialty fields [5]. The mission goal was to assist the local healthcare staff and facilities to overcome the tremendous damage and destruction to med- ical services and infrastructure.

Participating in a humanitarian aid mission is usually a gratifying and fulfilling endeavor but may also prove to be challenging task, full of uncertainties and difficulties especially when the delegation is rapidly assembled and deployed to an area hit with disaster of calamitous proportions. A simple but structured guideline may simplify the preparation phase for the team members. In this report, we sought to present our experience and lessons learned regarding the preparation of medical personnel for early response humanitarian aid delegations. We hope this will serve as a practical guideline and checklist for the team leader and medical specialist before embarking on such missions.

Our recommendations are based on our own and others' personal experience, lessons learned from previous delegations deployed by the IDF Medical Corps, staff briefings, group sessions and after action reports filed upon returning to Israel.

11.2 CASE PRESENTATION

11.2.1 Team Composition

The IDF has gained experience in deploying early response medical and humanitarian aid delegations to disaster zones around the globe [1,2] based on its ability to quickly recruit, prepare and equip medical and logistical personnel, some of which are called on through reserve duty. This medical aid delegation was assembled within hours and embarked to the Philippines. In cases of natural disasters with a multitude of casualties, rapid deployment is key in order to exert a beneficial effect to the local population in terms of morbidity and mortality [6]. As our delegation personnel was assembled from a relatively heterogeneous background, active and reserve duty alike, it required the appointed medical personnel to bring their everyday life to a sudden standstill and embark on an unknown and often disconcerting task [7].

Choosing the right personnel is one of the crucial components of successful mission planning and execution. We feel that putting together a delegation composed of health care providers with previous experience in natural disaster aid alongside first time participants is beneficial, as the more experienced

members usually help alleviate stress with practical knowhow and thus ease the preparation process for all. Integration of younger less experienced members also ensures and maintenance of organizational memory in medical aid deployment. The tradeoff of this approach of course was an initial lack of cohesiveness but on the other hand, it enabled a refreshing and empowering experience for the novice participants. This form recruitment strategy also enabled a "tailor made" solution for the region we were to operate in as gathered from site survey feedback. It is prudent to recruit personnel known to withstand stressful environments if possible as this might reduce future repercussions [8]. Team leaders, mental health specialists (essential part of the delegation) should be notified of at risk individuals.

Thus, optimal personnel recruitment in the mission-planning phase while still in the homeland is the initial and necessary step in achieving the mission's goals [7].

11.2.2 Briefing the Team

Briefing the appointed personnel while in the homeland alleviates stress and clears uncertainties which may hamper personnel functionality. It is important to under- score the fact that the briefing will contain information mostly from what is known about pre-disaster conditions in the destination, as site survey feedback from the scout team is often partial, inaccurate and may be sent back too late to exert a real difference on the delegation. Flexibility must be stressed as a vital quality for the healthcare provider and the delegation as a whole.

We suggest that briefing should be given as soon as the task force is assembled and should include the following agenda:

11.2.3 Destination's Geographic and Sociological Information

1. Destination area: world region, country, region, urban, rural, other.
2. Climate: day and night temperatures, humidity/ rain/snow.
3. Local language: need for translators, basic words for medical communication.
4. Endemic diseases: need for additional vaccinations and prophylactic treatments.
5. Sanitary conditions: is there any flowing water? Is it potable?
6. Personal safety: crime, terrorism, precautions to be taken.

7. Religion and culture, with emphasis of customs related to practical medicine. For example: can a male physician examine a female? What are the mourning customs? What are the burial rites and customs? Is it acceptable to send tissue which was removed during surgery for a pathologic exam or must it be buried? Are milk substitutes or pacifiers acceptable for infants?

11.2.4 Delegation Structure and Makeup

1. Mission goal—what are the main objectives as based on the needs of the local authorities, site survey feedback, personnel makeup and organizational orientation. Discuss team as well as personal expectations and set realistic goals for the delegation and the individual.
2. Delegation composition—who the personnel are, both medical, logistical and support staff. What is the appointed command chain?
3. Medical capabilities in surgical, intensive care (including pediatric), neonatal care, obstetrics, ancillary services (i.e. imaging, pharmacy and laboratory).
4. Basic organizational issues: routine schedule, sleeping and eating arrangements are important to emphasize. Delegation participants should be briefed on daily routines, as these tend to reduce uncertainty and create a sense of stability. Team leaders should display flexibility and urge delegation members to suggest necessary adjustments to the initial plan as the mission progresses.
5. Social support networks emphasis—Well-established social support networks were found to be beneficial in lowering the prevalence of mental implications. Recognition of this need, by both the individuals and the team leaders, is essential [7]. Providing the measures and encouraging delegation members to reach out to these networks back home (friends, family) or to bond and form new networks while in deployment should be emphasized as a part of the orientation and briefing.

Furthermore, as constant changes occur during the planning and execution of such missions, conceptual readiness for changes should be discussed as part of the briefing.

11.2.5 Essential Medical Considerations

1. Level of care: in most medical delegations it will not be possible to provide the same level of medical care as practiced at the delegations' origin

country. Contingencies will have to be made and ethical dilemmas faced. Some of these dilemmas have been discussed elsewhere [9,10] and it is beyond the scope of this article to address this aspect of the preparation process. Examples include the possible inability to conduct a pathologic examination for tissues removed during surgery in post-disaster conditions, decision making regarding incidental suspicious findings in the operating theatre and managing of surplus medical supplies at mission completion. Open staff discussion covering anticipated ethical dilemmas before deployment may assist the team upon arrival. It is essential to relay that ethical dilemmas are routine due to the extreme circumstances in natural disasters, have been encountered by the more experienced team members in past missions and should be resolved in open group discussions.

2. Work site: will an independent field hospital facility open or will the delegation work within or aside a local healthcare facility [5] and if so what will its capabilities include.
3. Collaboration with local or other healthcare personnel and facilities: the local population may receive care from a number of different caregivers and in these cases it is crucial to acknowledge the designated case manager and how continuity of care will be established upon mission completion.
4. Medical equipment: the appropriate type, quality and quantity of medical equipment are the keys for maximal humanitarian aid impact. Each specialist must personally verify his specific tools and medications. This should be done by a thorough review of a checklist composed beforehand while still in the homeland. Due to weight, space and other limitations, some equipment may be missing and the specialist may have to familiarize himself with several methods of performing medical procedures. It is not unusual that specialists may need to improvise at the scene if they lack their own tools or medications.
5. Medical routine: daily staff routine in the facility—timetable, shifts, rounds, staff meetings, patient admission and discharge procedures, ordering lab exams and radiology.
6. Patient case records: will the patient chart be recorded manually or digitally, in which language, and will he be given a hard copy. Will local physicians write the notes? Will records be left to the local staff?
7. Common practice issues:
   i. Obtaining patient informed consent before procedures.
   ii. Labor and delivery—treatment of women in the purperium, providing neonatal care, follow up and recommendations.

iii. Multitasking—Each caregiver will be asked to be responsible for tasks different from his specialty (both medical and auxiliary such as imaging etc.).

TABLE 11.1 Personal gear checklist for the healthcare provider in an early response medical humanitarian mission

Item	Details
Sandals	For shower and off-duty time
Toiletries	1. Towels 2. Soap, shampoo 3. Hand sanitizer 4. Shaving kit and scissors 5. Toilet paper for the first 3 days 6. Female hygienic products
Sleeping equipment	1. Sleeping bag (may need to be waterproof) 2. Personal Tent 3. Bed linen 4. Inflatable mattress 5. Pillow
Head light + batteries	At least 2 sets of batteries
Communication device (cell phone) + charger + international wall plug	pre-departure arrangements of an appropriate program with the mobile company are recommended
Camera	Can be part of the communication device
General supply	Pens, pencils, notebooks, marker (to mark your equipment),umbrella
Personal medical equipment	1. Stethoscope, surgical eye loops etc 2. Personal prescription medication 3. Contraception 4. Copy of medical diploma
Specialized medical equipment	In case certain gear requested will not be supplied by the delegation
Watch	
Musical instrument	Optional

11.2.6 Personal Gear

Early response medical humanitarian aid is usually based on governmental agencies, non-governmental organizations (NGOs) or military organizations. Therefore, in many cases, the organization will supply its own personal gear elements for the healthcare provider. Nevertheless, one should check that all the critical and optional equipment is present, according the geographic and sociological information which has been gathered. Table 12.1 shows our core recommended list of personal gear.

11.3 DISCUSSION AND EVALUATION

Prepping the medical provider along with provision of a structured check list before embarking on a medical humanitarian aid mission (especially in short time frames such as in response to natural disasters) should be a vital and mandatory part of the mission planning phase in the homeland. Previous publications have shown that only 85% of NGOs briefed their field personnel before deployment to an acute emergency settings [11].

Mental implications related to participating in humanitarian aid delegations vary, and may include anxiety and depression which may occur before, during and after deployment. Burnout—a work-related syndrome—is also frequently encountered among mission personnel. These detrimental mental effects may be reduced in frequency and severity by implementing proper preparation measures [8,11] such as reducing the uncertainty level by presenting relevant information during the briefings in the mission-planning phase [7].

The IDF-MC takes great pride in its humanitarian aid efforts and emergency medicine response to natural disasters as do other military forces, and nowadays as in the past, these are still considered core military missions [12]. Humanitarian response to crises employs an estimated 210000 people and accounts for billions of US dollars of spending annually [13]. One must also bear in mind that these undertakings are rarely considered effective [14] and are difficult to assess although various methods have been proposed [15]. Time allocated for preparation is scarce in most missions [16] and an optimal lengthy preparation process [17] is often not feasible. Thus, even in rapidly deployed missions, time allocated for personnel preparation and orientation may prove invaluable and ultimately may lead to a more efficient and effective execution phase.

11.4 CONCLUSION

Preparation of medical personnel for humanitarian aid medical missions is a complex and vital task that might be better accomplished with thorough briefing and structured checklists which begin with addressing of personal safety and other daily needs of the staff. More research regarding how preparation affects mission success is needed as well as determining how to improve the preparation process itself. Preparation may raise performance levels, lessen stress and anxiety symptoms for the health care providers and ultimately assist in achieving the delegations' goal of providing timely medical care to the local people struck by disaster.

REFERENCES

1. Bar-On E, Abargel A, Peleg K, Kreiss Y. Coping with the challenges of early disaster response: 24 years of field hospital experience after earthquakes. Disaster Med Public Health Prep. 2013;7:491–8.
2. Kreiss Y, Merin O, Peleg K, Levy G, Vinker S, Sagi R, et al. Early disaster response in Haiti: the Israeli field hospital experience. Ann Intern Med. 2010;153:45–8.
3. Asgary R, Junck E. New trends of short-term humanitarian medical volunteerism: professional and ethical considerations. J Med Ethics. 2013;39:625–31.
4. WHO coordinates health relief after typhoon Haiyan. Bull World Health Organ. 2013;91:900–1.
5. Merin O, Kreiss Y, Lin G, Pras E, Dagan AD. Collaboration in response to disaster - Typhoon Yolanda and an integrative model. N Engl J Med. 2014;19:19.
6. Haley TF, DeLorenzo RA. Military medical assistance following natural disasters: refining the rapid response. Prehosp Disaster Med. 2009;24(1):9–10.
7. Palmer I. ABC of conflict and disaster. Psychological aspects of providing medical humanitarian aid. BMJ. 2005;331:152–4.
8. Lopes Cardozo B, Gotway Crawford C, Eriksson C, Zhu J, Sabin M, Ager A, et al. Psychological distress, depression, anxiety, and burnout among international humanitarian aid workers: a longitudinal study. PLoS One. 2012;7:e44948.
9. Merin O, Ash N, Levy G, Schwaber MJ, Kreiss Y. The Israeli field hospital in Haiti–ethical dilemmas in early disaster response. N Engl J Med. 2010;362:e38.
10. Etienne M, Powell C, Amundson D. Healthcare ethics: the experience after the Haitian earthquake. Am J Disaster Med. 2010;5:141–7.
11. Moresky RT, Eliades MJ, Bhimani MA, Bunney EB, VanRooyen MJ. Preparing international relief workers for health care in the field: an evaluation of organizational practices. Prehosp Disaster Med. 2001;16:257–62.
12. DoD. Department of defense Instruction 6000.16. In: Book Department of defense Instruction 6000.16. 2010.
13. Walker P, Hein K, Russ C, Bertleff G, Caspersz D. A blueprint for professionalizing humanitarian assistance. Health Aff. 2010;29:2223–30.

14. Seybolt TB. Humanitarian Military Intervention The Conditions for Success and Failure. Great Clarendon Street, Oxford OX2 6DP: Oxford University Press; 2007.
Erlich et al. Disaster and Military Medicine 2015, 1:5 http://www.disastermilitarymedicine.com/content/1/1/5
15. Waller SG, Ward JB, Montalvo M, Cunliffe C, Beadling C, Riley K. A new paradigm for military humanitarian medical operations: mission-generic metrics. Mil Med. 2011;176:845–51.
16. Schaefer SM. Did you just ask if I would lead a humanitarian mission? Mil Med. 2008;173:954–9.
17. Solheim J, Edwards P. Planning a successful mission trip: the ins and outs. J Emerg Nurs. 2007;33:382–7.

CHAPTER 12

Nurses' Competencies in Disaster Nursing: Implications for Curriculum Development and Public Health

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12.1 INTRODUCTION

With disasters occurring more frequently threatening people around the world, the need to prepare nurses for disaster has never been greater [1]. Nurses should be equipped with the necessary knowledge and abilities to work in a disaster and to meet the needs of the respective serving community. However, more than 80% of nurses who volunteered to serve for a disaster event had no previous experience in disaster response [2]. It was recommended by the World Health Organization (WHO) that all nations, no matter how frequent (or infrequent) the happenings, should prepare healthcare workers for a disaster. Nevertheless, most nurses were inadequately prepared for disaster [3]. It is only through education and training can nurses can be equipped with the competencies required during disasters.

As the largest manpower group in the healthcare team, nurses play an important role in disaster care. Nurses' roles are not only in the emergency phase of a disaster, to rescue life and safeguard the health of the disaster sufferers, but in fact,

nurses have special roles in disaster preparedness and aftermath long-term recovery [4]. By providing leadership and guidance in different phases of a disaster, nurses can safeguard the health of the general public and reduce death tolls [5].

Nurses need to be competent in order to deal with disastrous situations. Competency refers to the actual performance of a person in a specific role, in a given situation [6]. It is defined as a combination of the knowledge, skills, abilities and behavior needed to carry out a job or special task [7]. Although there are many sets of competencies being developed to prepare healthcare workers to respond to disaster, they have been found inconsistent and imprecise. Disaster nursing core competencies specific to general nurses were limited or not verified. Further effort has to be made and directed toward the development of an accepted and adapted framework of competency for universal disaster nursing education [4].

The awareness of disaster preparedness and competencies among Hong Kong nurses is generally weak [8,9]. With limited research, training and education in the field of disaster nursing in Hong Kong, it is important to understand nurses' perceived competencies in disaster care prior to curriculum development. A better understanding of nurses' perceived competencies and their learning needs for disaster nursing is the first and essential step if nurse educators and health care administrators are to launch a disaster nursing course/continuing education program that meet the needs of nurses. This study adopted the framework of disaster nursing and key competencies delineated by International Council for Nurses and World Health Organization [10] as the standards to scrutiny Hong Kong nurses' level of competencies for disaster nursing.

12.2 THE ICN FRAMEWORK OF DISASTER NURSING COMPETENCIES

With an urge to develop a set of core competencies for disaster nursing education, the ICN launched a framework of disaster nursing competencies in 2009 for general nurses. It aims to work as a common set of competencies in disaster nursing for the global nursing workforce and to provide clarification of nurses' role in disasters [10]. The framework of nursing competencies should be applicable globally and the content can be modified to be culturally specific for different regions and places. It is also emphasized that in-country interpretation of the framework and regular review of the competencies is important to ensure relevancy to the community served.

The "ICN framework of disaster nursing competencies' was built on the "ICN framework of competencies for general nurse', which has been widely used as a guideline of nurses' competencies at an international level. The ICN disaster nursing competencies framework was developed according to the competencies in the areas of public health, mental health, healthcare workers, emergency managers, nursing and disaster nursing. The framework also based on the two sets of widely used disaster competencies for general nurses, the Nursing Emergency Preparedness Education Coalition [11] for mass casualty incidents and the Centre of Excellence, University of Hyogo (Kobe, Japan) [12] Disaster Competencies [10].

The ICN framework of disaster nursing competencies consists of four areas in the continuum of disaster management that corresponds to the four stages of disaster: the prevention, preparedness, response, and recovery stages. The four areas include ten domains, consists of a total of 130 items, in which nurses play numerous and multiple vital roles in disaster care and management [10].

12.3 STUDY METHODS

The aim of this study was to identify nurses' perceived competencies for disaster. The study was divided into two parts: focus group interviews and a written inquiry. The focus group interviews were to explore the competencies and knowledge of disaster nursing readily reported by the nurses with minimal guided questions or information. They were, given an explanation of what entails a disaster at the beginning of the interview sessions. The written inquiry was then followed, which consisted of a table specifying the four stages of disaster according to the ICN disaster framework as prompt, and nurses were asked to write down what they considered were the nursing competencies required for each of the four stages of disaster.

12.3.1 Participants/Sample Selection

The study focuses on nurses working in the medical/surgical, critical care and community health settings. These three groups of nurses were selected for their representativeness of the major nursing workforce during disaster. Medical and surgical nurses constitute the largest group in the nursing workforce; their competencies represent the competencies of general nursing for disaster care.

The critical care nurses work in high-dependency units including the intensive care unit and the emergency department; they are the first to response and help victims in disasters. The community health nurses work closely with the general public, and are most likely to understand the needs of the community they served. The perceived disaster nursing competencies of these three groups of nurses could provide a better understanding of the overall competencies level of Hong Kong nurses.

Nurse leaders from specialty associations, with extensive experience in their respective clinical specialty, were recruited for group interviews. There were four to six nurse leaders from the three specialties in each of the interview groups. Convenience sampling was used for the written inquiry. The participants were referred by senior nursing staff in hospitals or clinical settings. A total of thirty participants, ten from each specialty, were invited to complete the written open-ended inquiry.

12.3.2 Group Interviews

Group interviews were conducted separately among nurses in the three specialities. They were asked to state the competencies they considered to be necessary to handle disasters in their specialty area. Simple explanation on the definition of disaster was given. The interviews were tape-recorded and transcribed within one week after the interview. The interviewer repeated and summarized the participants' stated competencies to get an immediate indication of their agreement that the summary was a true and comprehensive list of their responses [13]. To ensure accuracy, these initial sets of compiled competencies were checked by two nurses, who verified the tabulated competencies separately to ensure exactness [14]. A table is used to summarize the nurses' perceived disaster competencies, which were tabulated according to the specialty areas and according to the domains of the ICN framework of disaster nursing competencies.

12.3.3 Written Inquiry

Written inquiry was conducted to further substantiate the findings of the group interviews. Written forms of data collection have the advantage of putting the participants under less pressure and giving them time to ponder upon what

are being asked. A table listing the four main disaster stages and ten domains of disaster nursing competencies according to the ICN disaster nursing competencies framework [10] was given to the nurses in the three specialty groups (general medical/surgical, critical care and community health) to further substantiate information collected from the group interviews. The questionnaire was distributed and collected by the researchers in person.

12.3.4 Data Analysis and Establishing Trustworthiness

Tabulation of the group interview responses was done in a systematic, sequential, verifiable way separately by the two researchers for the confirmability of the data. The interviews were audio-recorded and also preserved for repeat auditing. The transcription and tabulation of the data was done within one week of the interviews. The content (stated competencies) was categorized according to the four areas and ten domains of the ICN framework of disaster nursing. The tabulation were discussed and verified by the two researchers for rigor of the study [14].

For the written inquiry, the written responses of the specific competencies were directly categorized and tabulated under the four stages and 10 domains of the ICN framework of disaster nursing. The findings of the three interview groups and three written inquiry groups were merged in one table for ease of comparison.

12.3.5 Ethical Considerations

Ethical approval was obtained from the institute where the researchers work, and the conduct of the study was according to the stipulated regulation of the institute. The nurse participants were given an explanation of the aims of this study, and assured that participation was voluntary. All studies were completed in anonymity so that their personal identity could not be identified. Participants who willing to join the group interviews and being recorded, or complete the written inquiry were considered giving an implied consent to the study. The audio-recordings, notes and interview transcripts were anonymous, and contained only information on the nurses' specialties and work experience.

12.4 RESULTS

12.4.1 The Participants

A total of 45 nurses participated in the study, the majority of them were female (82%). Group interviews of 4–6 nurse leaders from the three specialties were conducted separately to explore nurses' perceived competencies in disaster management. All were experienced nurses with 3 to 23 years of experience, averaging of 17.2, 13.8, and 15.3 years of experience in the medical/surgical, critical and community specialty respectively (Table 12.1).

TABLE 12.1 Clinical experience of the participants.

Method of Data Collection	Medical/ Surgical	Critical Care	Community Unit
Focus groups			
No. of participants	6	5	4
Year of Experiences	9–23 years	3–20 years	8–23 years
Means	17.2 years	13.8 years	15.3
Open ended inquiry			
No. of participants	10	10	10
Year of Experiences	3–24 years	4–28 years	3–15 years
Means	16.4 years	14.7 years	10.7 years

A total of 30 participants, 10 from each specialty, were invited in the written inquiry study. They had 3 to 28 years of working experience in their specialty, with an average of 16.4, 14.7, and 10.7 years of experience in the medical/surgical, critical, and community specialty.

Hong Kong Nurses' Perceived Competencies for Disaster: Hong Kong nurses' perceived disaster competencies solicited from group interviews and written inquiry were tabulated under the four main areas (stages of disaster) of the ICN framework of disaster nursing competencies. The findings are discussed below according to the four stages of disasters (Table 12.2).

TABLE 12.2 Hong Kong nurses' perceived competencies for disaster care reported in focus group interviews ($n = 15$) and written inquiry ($n = 30$).

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
1. Risk Reduction, Disease Prevention and Health Promotion Risk Reduction and Disease Prevention (7) Health Promotion (5)	-Risk assessment and management	√	√	√	√	√	√
	-Adhere to infection control principles		√	√	√	√	√
	-Provide appropriate protective materials	√	√	√			√
	- Knowledge in disaster/illness and primary health care			√		√	√
	- Practice personal hygiene				√	√	
	- Preparation of health staff and the public in preventing disaster				√		
	- Provide relevant reference materials					√	
	- Work in a multidisciplinary approach to care	√					
	- Understand public health/epidemiology/ vaccination						√
	- Understand causes/mechanisms/ prevention of disaster				√		
	- Development of organizational and unit guidelines/protocol	√	√	√	√	√	√
	- Provide contingency planning		√	√	√	√	√
	- Plan (with protocol) for specific incident management	√	√	√			

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
2. Policy Development and Planning (11	- Infection control policy				√	√	√
	- Public health policy				√		√
	- Regular review of protocol						√
	- Risk management policy					√	
	- Fire safety and evacuation plan				√		
	- Quality and safety guidelines					√	
	- Occupational health and safety					√	
	- Manpower deployment plan		√		√		
	- Professional obligation to include disaster prevention, response, plan and recovery in practice				√		
	- Follow code of conduct				√		
3. Ethical Practice, Legal Practice and Accountability	- Legal liability and government overall disaster planning				√		
3.1. Ethical Practice (7)	- Establish, understand and reinforce laws on disaster prevention					√	
3.2. Legal Practice (5)	- No discrimination based on gender, religion, nationality, social status					√	
3.3. Accountability (5)							

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
	- Compliance with Privacy Ordinance					√	
	- Human dignity is important					√	
	- Patient charter					√	
	- According to HK Nursing Council code of conduct						√
	- Provide complaint system						√
	- Practice according to professional standard						√
	- Knowledge of legal practice						√
	- Develop communication skills	√	√	√	√		
	- Debriefing/incident reporting and meeting	√	√	√	√		
	- Use of various tools for communication		√				
4. Communication and Information Sharing (12)	- Establish fast and accurate communication of information system among government and non-government organizations, the community, hospitals and wards				√	√	√
	- Press release of information				√	√	
	- Yearly review, share information with other countries					√	
	- Use various tools for communication				√	√	

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
	- Familiarity with the data disclosure, communication, and information according to the guidelines						√
	-Provide: drill/audit/talk	√	√	√	√		
	- Knowledge and skill in different disaster situations	√	√	√			
	- Leadership skills	√	√	√			
5. Education and	- Understand role in disaster assignment	√		√			
Preparedness (12)	- Basic life support, CPR skills		√				
	- Updating information about new diseases				√		
	- Training in IT and communication skills				√		
	- Skills in psychological intervention				√		
	- Understanding of the nature of disasters				√		
	- Allocation/distribution of? limited resources	√	√	√		√	√
	- Knowledge of prioritizing care	√		√			
	- Active participation in rescuing activities				√		
	- Collaboration in community resources/ voluntary service					√	

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
6. Care of the Community (11)	- Reminder cards for management of specific disasters		√				
	- Care for the safety, security, access of food and water, medical care, temporary shelters, *etc.*					√	
	- Provide talks and a hotline in service area						√
	- Community services for different groups, e.g., geriatric assessment service						√
	- Personal safety, escape route			√			
	- Disaster preparedness plan for self and family						
	- Establish logistics for the care of victims				√		
7. Care of Individuals and Families	- Perform holistic care				√		
	- Help desk for enquiries				√		
7.1. Assessment (7)	- Form critical incident support team					√	
7.2. Implementation (18)	- Perform holistic care					√	
	- Familiar with different available resources, support network and referral for victims and families						√
	- Liaison with related social support					√	

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
	- Multidisciplinary approach to care					√	√
	- Psychological first aid and crisis intervention	√	√	√		√	
8. Psychological Care (9)	- Psychological assessment and counseling therapies for stressed staff and victims (form sharing groups)	√			√	√	√
	- Knowledge and skills in psychological/social aspect					√	
	- Adopt a multidisciplinary approach to care					√	√
	- Introduce coping skills and knowledge on disaster care						√
	- Post-Traumatic Stress Disorder care						√
	- Care of neglected groups with special needs			√	√		
	- Work in a multidisciplinary approach to care (voluntary service referral)					√	√
	- Understanding the needs of vulnerable populations					√	
9. Care of Vulnerable Populations (6)	- Special care and education for populations particularly vulnerable to disasters, *i.e.,* those with chronic illness, pregnant women and the fragile elderly, people with sensory disabilities				√	√	

TABLE 12.2 *(Continued)*

The 4 areas and 10 domains of the ICN Framework of Disaster Nursing Competencies		Focus group interviews			Written inquiry		
Prevention/Mitigation Competencies (total = 23)	**Competencies**	**Medical surgical nurses (n = 6)**	**Critical care nurses (n = 5)**	**Community nurses (n = 4)**	**Medical surgical nurses (n = 10)**	**Critical care nurses (n = 10**	**Community nurses (n = 10)**
	- Ability to identify vulnerable populations						√
	- Evaluation and planning in prevention and management during and after a disaster	√					√
10. Long-Term Individual,	- Restoration of normal service				√		
Family and Community Recovery	- Work and support by resources in a multidisciplinary approach to care					√	
	- Knowledge and skill in psychological and long-term care					√	
	- Participate in the development of an ordinance and community-wide policies to speed up recovery from disaster				√		
10.1. Individual and Family Recovery (7)	- Collaboration between community and family for post-disaster recovery						√
10.2. Community	- Learn and share					√	
Recovery (8)	- Systematic long-term care for disaster recovery						√
	- District support and resource allocation						√

12.4.2 Prevention and Mitigation Competencies

From the group interviews, there was consensus of nurses from all three specialties considered: "risk assessment and management", "provision of appropriate protective materials", "development and planning of organizational guidelines or protocol for disaster management", and "planning for specific incident management" as required disaster nursing competencies. However, only the critical care and community health nurses regarded "adhering to infection control principles" and "the need for contingency plans for disasters as important competencies in disaster prevention.

From the written inquiry, nurses of the three specialties identified that the "risk assessment and management" and "adherent to infection control principles" as important in disaster prevention. Only the community healthcare nurses considered "vaccination and epidemiology" as required competencies in disaster prevention. Whereas, the medical/surgical nurses expressed their concern on the "plan of manpower deployment", the critical care nurses concern about "occupational health and safety", and the community nurses highlighted the significant of "public health policy in disaster prevention planning".

12.4.3 Preparedness Competencies

In the interviews, "the knowledge of legal and ethical aspects of disaster care" was not addressed by any of the nurses. While all nurses across the three specialties were well aware of the importance of "developing good communication skills" and that "debriefing and incident reporting" was necessary. Education and preparedness for disaster related to "drills, audits or talks", and the "knowledge and skills in different disaster situation" were reported by nurses in all three specialties as required competencies.

The findings from written inquiry were somewhat different. All nurses recognized that "professional obligation" and "code of conduct" are the required competencies in disaster care. The medical/surgical nurses considered "legal liability" and "professional code of conducts" should be reinforced in disaster care. Critical care nurses acknowledged "human dignity" and "absence of discrimination" in disaster care, while the community nurses opined that there is need for "a complaint system" and knowledge of "legal practice". Nurses from all three specialties considered the need for "communication skills and reporting systems" and recommended the "use of various tools for communication and information sharing". Only the medical/surgical nurses were able to point out

the importance of "updating information about new diseases", "training in information technology and communication skills", "skills in psychological intervention", and "understanding the nature of disaster" as essential competencies.

12.4.4 Response Competencies

The interviews revealed that nurses from all three specialties regarded that "allocation and distribution of resources" during a disaster needed to be addressed, and they were concerned about "psychological care and crisis intervention" in a disaster. Both medical/surgical and community nurses regarded it necessary to have "knowledge of prioritizing care". Critical care nurses suggested the use of "reminder cards for management of specific disasters", in order to enable efficient triage and prioritize care. Only the community nurses aware of the fact that the establishment of "escape routes and personal safety" as disaster preparedness for the community. They also acknowledged that there is a need to care of "vulnerable groups as a neglected population with special needs".

From the written inquiry, the medical/surgical nurses addressed the need to establish "logistic for care of victims", "perform holistic care", and "help desk for enquires". The critical care and community nurses stressed the need for "multidisciplinary approach to care". Community health nurses emphasis the need for psychological care, including "introduce coping skills and knowledge on disaster care", and "post-traumatic stress disorder care".

12.4.5 Recovery and Rehabilitation Competencies

The findings of the interviews showed that only medical/surgical nurses talked about the important to have a plan for "evaluation and planning in management during and after a disaster". The findings of the written inquiry revealed that nurses in all three groups addressed the competencies of post-disaster care. Medical/surgical nurses identified the need to learn "restoration of normal services. Critical care nurses noted the significance of 'multidisciplinary approach' in the recovery stages of a disaster and the 'knowledge of psychological care for victims'. The community nurses emphasis the 'collaboration between community and family for post-disaster recovery', systematic long-term care for disaster recovery", and "district support in resources allocation", as well as "evaluating and planning for future disaster management".

12.5 DISCUSSION

There is a global need for all healthcare workers to be prepared and be competent in disaster care. Previous studies have found that most nurses were not adequately prepared [8,9]. The findings of the study indicated that nurses were not aware of their roles in preparing the community or the vulnerable population for disaster. In order to be prepared and be competent for disaster, all nurses should be equipped with knowledge and skills for disaster care through continue education and training. "Disaster nursing" has not yet been established as a core topic/subject to be included in nursing programs in Hong Kong, though it is a global demand for the inclusion of this component of disaster care in our education program. The findings of this study provide a clearer picture of the inadequate preparations of nurses for disaster, in that it provides nurse educators and/or health care administrators a guide to delineate a tailor-made education program for nurses.

The results of this study showed that Hong Kong nurses have some understanding of the needed competencies in "prevention, preparation, response, and recovery" phases of disaster care. In fact, the ICN has suggested in its disaster nursing framework that more attention is needed related to planning and preparation, as well as the understanding of the whole disaster management process. It is reflected that although there were quite a number of studies have focused on disaster response, there are also some studies conducted in Hong Kong on the disaster preparedness of families with young children [15] and elderly people [16] in Hong Kong. For post-disaster care, a study was also conducted that explore the experience of China nurses after the Sichuan earthquake rescue [17].

In the stage of "prevention and mitigation phase" of disaster care, the most neglected competencies were the "preparation of health staff and the public in preventing disaster", "regular review of protocol", and "quality and safety guideline". In the "preparedness" phase, the less mentioned competencies were "practice according to professional standard", "updating information about new diseases", "training in information technology and communication skill", "skills in psychological intervention", and "understanding of the nature of disaster". During the response phase, the competencies related to "forming critical incident support team", familiar with different resources, support network, and referral for victims and families', and the "ability to identify vulnerable populations", "post-traumatic stress care", and "care of special population with special needs", were not attended to. In the recovery phase, the competencies of "evaluation and planning of management after a disaster", "restoration of normal

service", "collaboration between community and family for post-disaster recovery", "systematic long-term care for disaster recovery" require more attention. If health workers are to prepare for disasters, all these competencies needed to be included in the all nursing curriculum and continuing nursing program.

None of the nurses in this study mentioned their own preparation and that of their families for disaster. A study in Hong Kong have found that the nurses' preparedness of their families affect their willingness to report to work during disaster [8]. Nurses, as well as all other health professionals, should be aware of the importance of being prepared individually and in their families, so that they can be ready to provide care during disaster, and to protect life. The message of being prepared for disaster should be conveyed to all members in the community through public education.

The special needs of vulnerable groups should be attended to in disaster to reduce damaging effects on health of the population and the death toll. Nurses should understand the risks and the needs of these special populations in their serving community and equip themselves to support them in disaster. Nurses should identify the vulnerable populations in the community, assist them in their special needs with special items available at home, the basic survival skills, where and how to get help. Checklists and education talks should also be developed and offered targeted these vulnerable groups.

12.6 CONCLUSIONS

This study explored the perceived disaster competencies of Hong Kong nurses and provides the needed background to inform educational needs. The findings of the study also provide hospital administrators the need to develop continuing education to prepare their nurses with the competencies for disaster care in their respective specialties. The study also shows that a context appropriate set of disaster nursing competencies is needed for Hong Kong nurses. The ICN framework can be used as a guide; with further modification and refinement to increase the applicability and validity of the competencies for the community we served [10,18].

With the increase frequency of disaster happenings globally, the need for education and training preparation is to be emphasized. A set of core competencies has also been defined as a starting point for delineating expected competency of health professionals in disaster medicine and public health [19]. Nurses should be adequately prepared with knowledge and skills for management of disasters,

starting early with their basic training and reinforcement in their on-the-job continuing training. Nurses, in all specialties, should be equipped for all competencies for disaster prevention, preparedness, response, and recovery phases. The public should also be prepared through disaster awareness promotion activities and health talks. The development of a comprehensive disaster nursing curriculum can protect our people in the community we served and shouldering the international responsibilities during disaster events in our nearby countries. In fact, disaster simulation has been used as an educational strategy to prepare nursing students for disaster respond, and has been incorporated into the undergraduate nursing curriculum [20], The simulation was found to increase nursing students' understanding of disaster preparedness, increase their ability and confidence to handle disastrous situations and working in teams.

In this early stage of developing disaster nursing in different societies, exploration of educational need, further research, and establishment of a set of core competencies for disaster nursing appropriate for the societal context are essential.

REFERENCES

1. Usher, K. Editorial: Are we ready? Preparing nurses to respond to disasters and emerging infectious diseases. J. Clin. Nurs. 2010, 19, 143–144.
2. Arbon, P.; Bobrowski, C.; Zeitz, K.; Hopper, C.; Williams, J.; Thitchener, J. Australian nurses volunteering for the Sumatra-Andaman earthquake and tsunami of 2004: A review of experience and analysis of data collected by the Tsunami Volunteer Hotline. Australas. Emerg. Nurs. J. 2006, 9, 171–178.
3. Weiner, E.; Irwin, M.; Trangenstein, P.; Gordon, J. Emergency preparedness curriculum in nursing schools in the United States. Nurs. Educ. Perspect. 2005, 26, 334–339.
4. Davies, K. Disaster preparedness and response: More than major incident initiation. Br. J. Nurs. 2005, 14, 868–871.
5. Subbarao, I.; Lyznicki, J.; Hsu, E.B.; Gebbie, K.M.; Markenson, D.; Barzansky, B.; Armstrong, J.H.; Gassimatis, E.G.; Coule, P.L.; Dallas, C.E.; et al. A consensus-based educational framework and competency set for the discipline of disaster medicine and public health preparedness. Disaster Med. Public Health Prep. 2008, 2, 57–68.
6. Daily, E.; Padjen, P.; Birnbaum, M. A review of competencies developed for disaster healthcare providers: Limitations of current processes and applicability. Prehosp. Disaster Med. 2010, 25, 387–395.
7. Wright, D. The Ultimate Guide to Competency Assessment in Health Care, 2nd ed.; Creative Healthcare Management: Minneapolis, MN, USA, 1998. [Google Scholar]
8. Fung, W.M.O.; Loke, A.Y.; Lai, K.Y.C. Disaster preparedness among Hong Kong nurses. J. Adv. Nurs. 2008, 62, 698–703.
9. Fung, O.W.M.; Lai, C.; Loke, A.Y. Nurses' perception of disaster: Implications for disaster preparation. J. Clin. Nurs. 2009, 18, 3165–3171.

10. World Health Organization (WHO); International Council of Nursing (ICN). ICN Framework of Disaster Nursing Competencies; World Health organization: Geneva, Switzerland, 2009.
11. Educational Competencies for Registered Nurses Responding to Mass Casualty Incidents. Available online: http://www.nursing.vanderbilt.edu/incmce/competencies.html (accessed on 17 March 2014).
12. WHO Collaborating Center for Nursing in disasters and Health Emergency Management; University of Hyogo. Core Competencies Required for Disaster Nursing. Available online: http://www.coe-cnas.jp/who/eng/group_education/core_competencies_list.html/ (accessed on 17 March 2014).
13. Krueger, R.A. Analyzing and Reporting Focus Group Results; SAGE Publications, Inc.: London, UK, 1998.
14. Lincoln, Y.S. Naturalistic Inquiry; SAGE Publications Inc: Newbury Park, CA, USA, 1985.
15. Fung, O.W.M.; Loke, A.Y. Disaster preparedness of families with young children in Hong Kong. Scand. J. Public Health 2010, 38, 880–888.
16. Loke, A.Y.; Lai, C.; Fung, O.W.M. At home disasters preparedness of elderly people in Hong Kong. Geriatr. Gerontol. Int. 2012, 12, 524–531.
17. Liu, X.W.; Fung, O.; Loke, A.Y. The experience of Chinese nurses in the earthquake rescue. Chin. Nurs. Res. 2012, 26, 1935–1938.
18. Bond, E.F.; Beaten, R. Disaster nursing curriculum development based on vulnerability assessment in the Pacific Northwest. Nurs. Clin. North Am. 2005, 40, 441–451.
19. Walsh, L.; Subbarao, I.; Gebbie, K.; Schor, K.W.; Lyznicki, J.; Strauss-Riggs, K.; Cooper, A.; Hsu, E.B.; King, R.V.; Mitas, J.A., II; et al. Core competencies for disaster medicine and public health. Disaster Med. Public Health Prep. 2012, 6, 44–52.
20. Kaplan, B.G.; Connor, A.; Ferranti, E.P.; Holmes, L.; Spencer, L. Use of an emergency preparedness disaster simulation with undergraduate nursing students. Public Health Nurs. 2012, 29, 44–51.

CHAPTER 13

Global Health and Emergency Care: An Undergraduate Medical Education Consensus-based Research Agenda

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13.1 RATIONALE FOR A RESEARCH AGENDA

Given the popularity of global health and global emergency medicine (EM) educational endeavors, it is crucial to outline a research agenda in these areas. It is assumed, for example, that global health educational experiences result in positive outcomes for medical students and for patients under their care (both of the local medical school hospital and at the overseas host site). This, however, may not prove to be the case, and only through a well-laid-out and executed research agenda can this be determined.

The positive or negative findings of research in global health medical education create opportunities to improve these experiences and to share and implement best practices. With this research also comes the opportunity to enhance specific outcomes for medical students and for patients and populations (local and abroad) under their care.

 Academic Emergency Medicine *2013;20:1224–1232. This article reports on a breakout session of the May 2013 Academic Emergency Medicine consensus conference in Atlanta, GA: "Global Health and Emergency Care: A Research Agenda." Used with permission of the authors.*

Perhaps just as important is a global health education–related research agenda that evaluates the effect on global health educators at the undergraduate medical education level. For example, are medical school global health academicians promoted with equal parity to their non–global health academic counterparts? To continue to grow global health research and education initiatives, universities will need to give greater recognition and reward to such nontraditional academic endeavors for promotion and tenure.[1]

In this article, a consensus-based research agenda will be presented and will highlight five priority research questions related to global health education at the undergraduate medical education level.

13.2 RESEARCH QUESTION 1: WHAT IS THE CURRENT SCOPE OF GLOBAL HEALTH EDUCATION AT THE UNDERGRADUATE MEDICAL EDUCATION LEVEL?

13.2.1 State of Global Health Education at the Undergraduate Medical Education Level

Given the growing interest in global health opportunities, many American and Canadian medical schools have integrated global health into their curricula. Successful implementation of these global health opportunities can prove to be a powerful recruitment tool. In addition, medical schools recognize that global health education helps to enhance student understanding of population-based medicine.[2]

Sixty-eight percent of surveyed United States medical schools now have student global/international health interest groups. According to a survey conducted by Khan et al., [3] about 90% of U.S. medical schools self-reported as offering global health opportunities. Specifically, 39% of these schools offered didactic coursework in global health, and 47% offered overseas experiences for students.

The 2012 Association of American Medical Colleges (AAMC) graduation questionnaire survey reported that 30% of responding students had participated in global health experiences.[4] To meet this demand, educators have begun to develop and implement curricula. Over the past few decades, there has been the acknowledgement of this educational need in the creation of groups dedicated to global health education, such as the Global Health Education Consortium, the

American Medical Association Office of International Medicine, and the Global Health Action Committee of the American Medical Student Association.[5] Despite these recognized first steps to accommodate educational demand, there is still a great deal of variation in global health education for medical students [6] and a general call for more standardized curriculum development.[7]

In July 2013, the AAMC launched the pilot phase of the Global Health Learning Opportunities (GHLO) program.[8] GHLO is a collaboration of 10 select U.S. medical institutions and 14 international institutions participating in a Web-based application service that "facilitates clinical, global health, and research elective rotations internationally for fourth-year medical students."[9] GHLO innovatively consolidates universal tasks of international elective programs and applicants, including streamlining of application processes for students, alleviating home institution difficulties in tracking students' progress, and strengthening host institutions' ability to manage selection and evaluation processes.[10] GHLO host institutions have autonomy and establish respective prerequisites for rotation participation (e.g., coursework, language requirements), but they are required to offer high-quality experiences; collaborate dynamically with GHLO partners; provide technical infrastructure and support; and acknowledge the necessity of pre-rotation, on-site, and post-rotation support for participants.[9] The investment in GHLO by the AAMC is a remarkable contribution to the global health education of its pilot member institutions' medical students, and it has the potential to foster opportunities for many more schools of medicine.

Historically, global health education has taken various forms, such as didactic lectures or seminars, clinical rotations abroad, attendance at meetings with a global health focus, participation in research with international researchers or at international sites, and student interest groups. Additionally, several different models have been used to further global health education, such as partnering with a school of public health, focusing on globally applicable biomedical research, partnering with nongovernmental organizations or private foundations, and creating global health "tracks" for medical students.[5]

Currently, no consensus exists on best practices of education methods to teach global health. Several groups have attempted to create frameworks for global health curriculum development [11-13] and suggested core content [5], but a much more comprehensive analysis and discussion is needed.

13.2.2 Metrics for Assessing and Evaluating Undergraduate Medical Education Global Health Education Programs

Current literature detailing the outputs and outcomes related to medical school global health education programs are mostly descriptive. Surveys regarding curricula, [14] competencies and skills achieved by students [15-17] and case reports describing a specific university's experience with the development and inclusion of a global health curriculum [18, 19] are examples of these descriptive studies.

While minimal literature focuses on the evaluation of undergraduate medical education in global health, there are several published resources and examples of outputs for medical school global health education programs in the literature and available online. Working groups from many regions have aligned to propose core competencies and best practice guidelines for programs in global health, as described in the 2013 literature review by Khan et al. [3, 20-25] As another example, the Liaison Committee on Medical Education offers a 30-hour standard curriculum in global health as a "necessary minimum for future physicians to be competent to treat changing populations."[23]

After a review of the literature of published curricula and guidelines, as well as an analysis of the International Opportunities in Medical Education database, Kahn and colleagues [3] assert that, going forward, global health educators will need to further use evidence-based methods to standardize global health curricula to ensure a practical, testable level of students' skills. The authors recommend that a dedicated global health textbook for medical students accompany this curriculum. Additionally, medical schools should engage parent university leadership, as the buy-in of leaders beyond the school of medicine is critical for ongoing international partnerships, support for students in both travel practicalities and legal agreements, and protected time for global health faculty. This support will also assist parent universities in assuring that international partnerships are also equitable and appropriate for partners abroad. The current online learning resource centers, published curricula, and databases of educational opportunities represent important methods to track outputs of undergraduate medical education global health programs. Moving forward, researchers will need to assess long-term educational outcomes for participating students, faculty, and institutions.

The International Federation for Emergency Medicine has taken a slightly different and more specific approach—recommending essential elements of the specialty of EM for inclusion in medical student education in medical schools

across the globe.[26] Students considering global health need clear learning objectives and evaluation metrics. Parent universities fortifying collaborations in standardizing core elements of a state-of-the-art global health curriculum will assist in better evaluation and measurement of the outcomes of such programs for participants—both for students, as frequently evaluated in the past, and also for global health faculty.

Key metrics for assessment and evaluation of global health programs at medical schools may include numbers of participating students and faculty; number of resulting courses; programs; presentations; grants; publications; and surveys of knowledge, attitudes, and practice. In addition, longitudinal cohort studies, at multiple institutions, can be instituted to address whether global health and global EM academicians are promoted with equal parity to their non–global health academic counterparts.

13.3 RESEARCH QUESTION 2: HOW TO EVALUATE AND MEASURE THE IMPACT OF NEXT-GENERATION GLOBAL HEALTH EDUCATION MODALITIES AT THE UNDERGRADUATE MEDICAL EDUCATION LEVEL?

13.3.1 Future Content

Global health training within undergraduate medical education has rapidly evolved during the past decade.[14, 27, 28] Three specific education areas will need to be addressed to advance global health education for medical students: curricular content, teaching modalities, and competencies.

The content for structured global health training within undergraduate medical education can be divided into three topic areas that include preclinical concepts, clinical concepts, and social determinants of health concepts (Table 13.1). These divisions allow for global health training prior to the delivery of patient care, at which time interdisciplinary theoretical concepts, such as global health policy, global health economics, and global food security can be intertwined with theoretical medicine. During clinical training, medical students can study diseases that affect patients in a variety of global settings, including infectious diseases, pediatric illnesses, and mental health. The third content area, social determinants of health, spans both preclinical and clinical training, and it can be included longitudinally throughout undergraduate medical education training. [29] Specifically for EM, clinical topics may include trauma care,

prehospital care, acute presentations of noncommunicable diseases, pediatric emergencies, and obstetric complications.

TABLE 13.1 Future Content for Global Health Undergraduate Medical Education

Content Area	Global Health Topics
Preclinical topics	1. Communicable diseases
	2. Noncommunicable diseases
	3. Medical ethics and human rights
	4. Hygiene and sanitation
	5. Food security and nutrition
	6. Health economics
	7. Health policy and comparative health systems
	8. Injury prevention
	9. Health education and promotion
	10. Technology and health care
Clinical topics	1. HIV/AIDS
	2. Tuberculosis
	3. Malaria
	4. Diarrheal diseases
	5. Tropical medicine
	6. Respiratory diseases
	7. Diabetes
	8. Cardiovascular diseases and hypertension
	9. Obstetrics and gynecology
	10. Pediatrics
	11. Mental health
Social determinants of health	1. Socioeconomic and structural factors of health inequities
	2. Money; power; and resources at local, national, and global levels
	3. Integrated policy approaches
	4. Interrelated sectors (such as food, water, housing, and energy) impact on health outcomes

13.3.2 Future Teaching Modalities

Effective transfer (from teacher to student) of global health knowledge and skills will require robust teaching modalities beyond mere classroom didactics. Future teaching modalities will need to incorporate simulation technology, team-based learning, cased-based learning (with specific content for global health scenarios), and Web-based education platforms. In addition, tele-education will provide the opportunity to link participants from around the world, both educators and students, into global health education efforts. For example, through tele-education, teachers and students at both a U.S. institution and an international institution can discuss cases and conduct active learning, and when a student exchange occurs, the same small group can continue the group discussion even though the students have changed locations.

13.3.3 Future Competencies

Along with focused global health curricular content and innovative teaching modalities, specific competencies in global health education will need to be modified and expanded to establish effective undergraduate medical education global health learning platforms at medical schools. In addition to core content knowledge about global diseases and public health issues, students will benefit from advanced global health competencies that will allow them to take skills with them into residency and later into their careers as independent practitioners (Table 13.2). In addition to established core competencies for medical students that can be integrated into global health curricula, these advanced competencies help train medical students with skills that allow for more effective lifelong practice of global health.

TABLE 13.2 Advanced Global Health Competencies for Medical Students

1. Needs assessments of local populations
2. Effective prevention strategies
3. Health promotion
4. Ethics of research in international settings
5. Evaluation of effectiveness of interventions

13.3.4 Metrics for Evaluating Novel Global Health Education Programs at the Undergraduate Medical Education Level and Student Performance in These Programs

When educators discuss evaluation methods for medical students in global health experiences, they must consider lessons learned and best practices to guide our future assessment modalities in the undergraduate medical education setting. Taking into consideration previous graduate medical education (GME) core competencies, and the current transition to the GME Milestones, student evaluations should also be multisource, compiling feedback from supervisors, peers, health care personnel, and patients. Because milestones allow for competency-based rather than time-based progression, they are particularly useful for a longitudinal "track" experience in global health in a medical school curriculum. While milestones require a minimum competency at outset, and a specific benchmark competency for progression to the next level of training, a learner may not achieve a maximum score at the completion of an experience. In fact, the highest score is meant for an expert practitioner, and the expectation is that learners gradually increase as they progress through their education from undergraduate medical education to GME and into lifelong learning. Perhaps, milestones achieved in medical school can be used to confer advanced status in GME global health competencies.

A lack of consensus exists, however, of the specific learner competencies that should be assessed [25] or of how learners and programs should be evaluated. Valid assessment is essential to determining the success of an individual or an educational program. To effectively evaluate the learner or program, the curriculum must be paired with the evaluation modality. The assessment tool used will be dependent on the competency it is measuring, and multiple assessment tools may be required for a comprehensive appraisal of a program or an individual's skill. Professional organizations have initiated the compilation of toolkits for global health resources, including evaluation tools.[30]

Examples of tools to evaluate learners include surveys (rating scales, free-response, etc.), objective structured clinical examination (OSCE) standardized patients or simulation cases, direct observation, written examinations, oral examinations, and preceptor evaluations. Specific competencies will lend themselves best to particular types of assessment. For example, a question related to the competency of "global burden of disease and morbidity and mortality classification" may be best measured as a purely recall question. In this case, a student could be asked to "Describe how the major categories of morbidity and

mortality used by the World Health Organization vary by age" for communicable and parasitic diseases versus noncommunicable conditions versus injuries. The competency, "health care utilization in low-resource settings," however, may be better addressed using a simulated scenario or OSCE. In this case an evaluation may require that a student "Demonstrate the ability to adapt clinical skills and practice in a resource-constrained setting." To demonstrate competency in this area, students should: "Identify symptoms and signs for common major diseases that facilitate diagnosis in the absence of advanced testing often unavailable in low-resource settings." A student might accomplish this via demonstration of his or her ability to diagnose and to treat a case of suspected tuberculosis or pneumonia without accessibility of x-ray.[31] Table 14.3 shows an example of competency domains and linked assessment methods.[32]

As the focus in medical education changes to outcomes-based education, performance-level standards may also be adopted for the evaluation of outcomes in global health. At the individual level, a performance-level schema (for example, novice, advanced competent, expert, and master) and professional activity confidence levels, defined by clear rubrics, could be used to guide the evaluations of global health learners in medical schools.[33] Portfolios are also useful for this process when combined with reflections and formal written feedback in a 360-degree manner.[34, 35] The 360-degree evaluation method would require evaluations from the host communities in addition to our own local faculty, staff, and students. This process could include not only evaluation of learning outcomes, but also results for the international partners, including benefits of such a relationship to the community (development of new protocols or programs, availability of specialists, equipment, etc.), as well as costs, including the time spent focusing on a visiting learner.

At the same time, methods to evaluate (and measure the effect of) medical school programs in global health with objective and standardized evaluations must be developed. Better tools for evaluating global health curricula will allow schools to collect more robust data on the efficacy and value of these programs. When creating these methods, medical education research on evaluating students in different settings should be considered. Indeed, one difficulty encountered is that the settings of didactics as well as electives and populations served vary markedly. It can be difficult to compare programs working in different economic and geographic settings and those focusing on different types of practice such as research versus clinical.

TABLE 13.3 Aligning Competencies at the Abstract and Contextual Levels With Evaluation and Teaching Methods Using Pediatric Diarrhea as an Example

Competency Area	Competency in Context: Child With Diarrheal Disease	Teaching Method Options	Evaluation Methods
Communication Skills	The learner explains to parents different causes of diarrhea in the child in a clear manner.	Formalized learning using simulation. Assigned reading on pediatric diarrheal pathologies and treatment.	Standardized patient exercise
Basic clinical skills	Using physical examination skills, the learner identifies the signs of dehydration in the child.	Simulation/mannequin practice. Physical examination textbook. Supervised clinical experiences.	Structured direct observation and feedback. Standardized patient examination.
Using evidence-based medicine to guide diagnosis, management, and prevention	The learner identifies community-based resources to assist parents in improved household sanitation and hygiene.	Self-guided research. Assigned readings. Small group sessions.	Written examination
Moral reasoning and medical ethics	The learner explains the most important competing issues that weigh in the decision to use scarce resources, such as oral rehydration therapy, intravenous fluids, and inpatient admission	Small group discussion of case scenarios. Programmed reading.	Oral examination
Problem-solving	The learner appropriately identifies and refers acutely ill children with severe dehydration and sepsis to an increased- capacity hospital for critical care.	Small group discussion with scripted patient management problems. Assigned problem set with feedback.	Chart audit
Professionalism	The learner obtains appropriate parental consent prior to the care of children.	Lecture. Self-directed review of confidentiality policy.	Supervisor evaluation

Adapted from Gruppen et al.[32]

13.4 RESEARCH QUESTION 3: WHAT IS THE LONG-TERM IMPACT TO MEDICAL STUDENTS?

To better measure the value of global health education, the long-term effects on medical students must be assessed. To date, the "enthusiasm (of students) has not been matched by medical educators' interest (or ability) to evaluate international health experiences with more rigorous studies."[17] To this point, the vast majority of the current body of literature in this area focuses on self-evaluations using Likert scales and changes in knowledge, attitudes, and practices within a short time after an overseas rotation.[15, 17]

The review by Battat et al.[25] of the global health literature listed several outcomes in experiential learning. In implementing these evidence-based outcomes, one should aspire to evaluate and to measure them with validated methods. There are little data on the best practices for evaluating experiential global health–related learning in medical students, as well as a lack of well-developed rigorous studies measuring outcomes to these students. It can be difficult to quantify what are often nebulous outcomes. Those available continue to suggest reflection,[36] as well as attempting to tie outcomes measures to previously defined learning goals.

13.4.1 Examples of Methodologies for Measuring Medical Student Outputs and Outcomes to Medical Students

13.4.1.1 The Kirkpatrick Model

One of the most commonly used models for evaluation is the Kirkpatrick Four Levels evaluation model.[37] The four levels described detail various categories of assessment that can help objectively analyze the effectiveness and impact of a training program or learning process.

- Kirkpatrick Level 1 (Reaction): Surveys, focus groups, interviews, facilitated reflection, and debriefing sessions.
- Kirkpatrick Level 2 (Learning): Written and oral examinations, standardized patient encounters.
- Kirkpatrick Level 3 (Behavior): Direct observation, preceptor and patient evaluations (evaluating cultural sensitivity, communication skills, etc.)

- Kirkpatrick Level 4 (Outcomes): Specialty choice and practice environment of trainees, role in public health domain, number of global health–related publications, patient outcomes, money spent or saved on diagnostic testing to reflect cost-effectiveness, quality ratings.

Much of the current literature is based on Kirkpatrick Level 1 outcomes, which provide little objective value and just begin to analyze these programs. To better review both the short- and long-term effects on medical students, higher-level Kirkpatrick outcomes must be sought. In the global health arena with a great number of unpredictable variables, the separation of researchers and subjects by time and space, and the regulations and practices of multiple cultures and societies, higher-level assessments may be difficult. Despite these challenges, global health researchers and the communities that they serve are calling for higher-level, quality studies, and the field of global health and emergency care will benefit greatly from such research endeavors. Clearly, the existing body of evidence is limited, and population and impact studies are difficult to complete. Medical schools participating in global health education could take this opportunity to attempt to develop cohorts for ongoing research about the lasting value of these opportunities for students and work together to start to quantify results for host communities.

13.4.2 Metrics For Evaluating Long-Term Impact of Global Health Education Programs on Medical Students

One possible method for evaluating Kirkpatrick Level 4 outcomes will be to assess how global health education influences the future careers of medical students. Some literature suggests that medical students participating in global health activities may be more likely to select specialties in primary care, but these data do not provide clear causation. Using longitudinal prospective medical student cohorts at individual medical schools or at multiple institutions, the potential effects of global health experiences can be evaluated:

- specialty choice
- geographic setting of practice (urban vs. rural)
- location of practice (state, country)
- academic or community practice
- care of underserved populations

Research may include selecting students with similar baseline characteristics and then comparing cohorts of students in global health activities with those who do not engage in global health experiences. In addition, is there a relation between global health education as a medical student and future training or careers in public health or fellowships and work in global health? Do medical students who participate in global health activities choose to research global health issues and publish papers on related topics? How many students who were involved in global health education at the undergraduate level go on to have careers where a large portion of their time is devoted to global health? These are important questions to determine if global health education has a significant effect on medical students.

13.5 RESEARCH QUESTION 4: WHAT IS THE COST AND VALUE TO U.S. MEDICAL SCHOOLS?

13.5.1 Sources of Funding

Global health funding at the medical school level in the United States often exists as an amalgam of donors and contributors. These include private and nonprofit organizations and endowments; public entities at the international, federal, and state level; personal fundraising by medical students and faculty; and host-country funds earmarked for special projects. The scope and scale of global health activity determine the composition of the basket of donors at medical schools seeking to balance service with education.

13.5.2 Value to Medical Schools

Global health programs provide opportunities for medical students to serve an ever-diverse patient population with clinical confidence and cross-cultural sensitivity.[38] Moreover, these programs offer a proactive stance to seeking the biophysical and social determinants of health and well-being of growing population segments within the United States. Global health programs at medical schools remove students from highly technical care environments and place them in resource-limited settings with similar outcome expectations. The newfound sensitivity to costs and resources has the potential to drive innovation both abroad and at home.[17] At the federal level, the U.S. Department of Health and Human Services has outlined global health as a high-profile ambassadorship of

the United States to regions of the world that stand to gain from a vital relationship and where we currently have limited collaboration.[39] Global health programs make teleologic sense to medical schools in the United States seeking to recruit intellectual capital drawn to the medical challenges of our time.

Three significant root causes drive the growth of global health on U.S. campuses. First, in response to students' great awareness of global issues through media and the Internet, U.S. higher education is placing greater emphasis on internationalization and requesting resources from donors to meet this demand. Second, the public visibility of the global health agenda and U.S. foreign policy encourages academic institutions to be more engaged in the larger movement for greater global equity. Third, increased fiscal resources from the U.S. government, foundations, and private and corporate philanthropy have created new opportunities for universities to pursue global health agendas and create training paths for students.[27]

13.5.3 Metrics for Evaluating the Value of Global Health Education Programs to U.S. Academic Medical Centers and their Patients

Global health programs can bring monetary value to patients in the United States. Resource limitations on diagnostic testing and increased reliance on physical diagnosis abroad may lead to cost savings and lower diagnostic test utilization rates at home.[40] Less obvious, but equally important, global health programs engender a pipeline of long-term providers for underserved communities in the United States.[40, 41]

There is also nonmonetary value to patients, as medical providers (who have undergone global health training) anticipate illnesses that cross borders and provide public health guidance.[42] Diseases such as SARS and avian influenza have the potential to arrive within local U.S. communities, and physicians with an awareness of global health care trends may be able to identify these public health threats at an early stage.[43] Likewise, exposure to illnesses more common in global health settings, like Chagas disease and malaria, can broaden the diagnostic capacity of practitioners in the United States, thereby benefiting patients. Last, global health programs at medical schools can also advance the therapeutic relationship through engagement with populations unaccustomed to navigating the U.S. health care system.

The qualitative value of global health programs at medical schools may be derived, in part, through 360-degree evaluations from medical students, faculty, patients, and ancillary staff both at home and in the host country. The current methodology of Likert self-report surveys suffers from selection bias. Long-term multi-institutional cohort studies may offer an alternative to properly tracking career choice, location, trajectory, and longevity of global health participants in United States medical schools. No matter the methodology for evaluation or measurement of impact, a formal needs assessment is an essential early step in development of any program. This process will facilitate understanding of the current state of education and emergency care training, existing infrastructure, and present gaps.[44]

13.6 RESEARCH QUESTION 5: WHAT ARE THE VALUE, IMPACT, AND BURDEN TO INTERNATIONAL HOST COUNTRIES AND THEIR INSTITUTIONS?

There are many motivations for institutions to host global health student experiences. In a study of Namibian practitioner-hosts, interviewees were happy to share their knowledge and unique learning environment with students from another country, even when the trainees were not perceived to offer personal or local patient benefit.[45] Most often, however, institutions enter into such host relationships to facilitate broader goals. Some look to build local esteem through foreign affiliations—aiding in host notoriety and allowing recruitment and retention of the community's best physicians. Others cite financial incentives—opportunities for tuitions, fees, and grants, as well as access to supplies and medications that may be otherwise unavailable. A third category includes educational opportunities—knowledge transfer and prospects for improved health care delivery and community empowerment.[46] Finally, institutions may participate in hopes of developing partnerships facilitating research and scholarly writing as well as student and faculty exchange.

Negative effects on host preceptors and communities also exist.[46] They often bear burdens such as uncompensated teaching time and increased administrative loads to accommodate visiting students with no formal training for these roles. Further, the host supervisors are responsible for preventing visiting students from creating cultural obstacles to patients' access to health care and may shift available mentorship away from domestic students.[46]

Additional opportunity costs may include the shunting of patients from local clinics to those served by visiting teams and limiting local staff's time to generate income attending to private patients. Communities may also have negative effects based on limited availability of resources and lack of follow-up or available prescriptions after specialized procedures when visiting medical teams return home.

Crump and the working group on ethics guidelines for global health training (WEIGHT) assert some best practices to limit these burdens, including first respecting local objectives and concerns when developing partnerships and setting clear expectations for roles and responsibilities of both visitors and hosts and their respective institutions. They advocate calculating the financial burden to all involved stakeholders (including administration, orientation, insurance, lodging, health care, and supervision/mentoring) and compensating them fairly. Further, they ask programs to encourage frank discussions to delineate motivations and potential conflicts of interest related to the development of such programs. The WEIGHT group advocates formal training for all involved parties to ensure safety and culturally appropriate practices consistent with the learner's level of training.[47]

13.6.1 Metrics for Evaluating Value, Impact, and Burden on Host Countries and their Institutions

There is a paucity of literature detailing the benefits to trainees participating in global health experiences or the importance of reciprocating benefits to local host communities. Such data should be collected in several forms: quantitative reports, including numbers of scholarly publications; grants; and programs resulting from such partnerships could be collated. Interviews and surveys could be conducted from host physicians, staff, and patients regarding both their perceptions and opportunity costs. Case reports of outcomes in communities and successful (and challenging) collaborations should be circulated to disseminate lessons learned and best practices. Finally, institutions providing undergraduate medical education global health experiences should collaborate to conduct higher-level research (for example, Kirkpatrick Level 4), including longitudinal studies of participating students, hosts, and communities to further elucidate the benefits and costs to host institutions and patients.

13.7 CONCLUSIONS

Global emergency medicine is a subset of emergency medicine focused on the improvement of emergency care in other parts of the world, without regard to geography, through educational programs, clinical care, and investigative research. The efforts embodied by the term global emergency medicine consider emergency care capacity as well as the health of the entire planet.[48]

The consensus-based research questions related to global health education at the undergraduate medical education level include:

- What is the current scope of global health education at the undergraduate medical education level?
- How should the impact of next-generation global health education modalities at the undergraduate medical education level be evaluated and measured?
- What is the long-term impact to medical students?
- What is the cost and value to U.S. medical schools?
- What are the value, impact, and burden to international host countries and their institutions?

Whether positive or negative, findings of research in global health medical education create opportunities to improve medical school global health experiences and to share and implement best practices. These findings also provide an opportunity to enhance specific outcomes to medical students and to patients and populations under their care.

No matter the methodology for attempting to answer individual research questions on this agenda, conducting a prospective formal needs assessment in collaboration with invested local partners is an invaluable tool for defining needs and priorities.

Potential tools to evaluate learners include surveys, OSCE standardized patients or simulation cases, direct observation, written and oral examinations, and preceptor evaluation. Utilization of longitudinal cohorts and other methods could serve as powerful means for determining how significant an effect global health education has been on medical students.

In addition, better tools for evaluating global health curricula will allow medical schools to collect more robust data on the efficacy and value of these programs to learners and to patients here in the United States and abroad. Employing the Kirkpatrick Four Levels Evaluation Model, particularly Level 4

(outcomes), can be a crucial strategy for measuring the effects of undergraduate medical education efforts geared towards global health and emergency care.

REFERENCES

1. Walker S, Ouellette V, Ridde V. How can PhD research contribute to the global health research agenda? Can J Pub Health. 2006; 97:145–8.
2. Goldner B, Bollinger R. Global health education for medical students: new learning opportunities and strategies. Med Teach. 2012; 34:e58–63.
3. Khan OA, Guerrant R, Sanders J, et al. Global health education in U.S. medical schools. BMC Med Educ. 2013; 13:3.
4. Association of American Medical Colleges. Medical School Graduate Questionnaire: 2012 All Schools Summary Report. Available at: https://www.aamc.org/download/300448/data/2012gqallschoolssummaryreport.pdf. Accessed Oct 1, 2013.
5. Evert J. Developing Global Health Curricula: A Guidebook for US Medical Schools. Washington DC: Global Health Education Consortium, 2006.
6. Izadnegahdar R, Correia S, Ohata B, et al. Global health in Canadian medical education: current practices and opportunities. Acad Med. 2008; 83:192–8.
7. Brewer T, Saba N, Clair V. From boutique to basic: a call for standardized medical education in global health. Med Educ. 2009; 43:930–33.
8. Association of American Medical Colleges. Global Health Leadership Opportunities. Student Frequently Asked Questions. Available at: https://www.aamc.org/services/ghlo/faq/. Accessed Oct 1, 2013.
9. Association of American Medical Colleges. About GHLO. Available at: https://www.aamc.org/services/ghlo/about/. Accessed Oct 1, 2013.
10. Association of American Medical Colleges. Global Health Leadership Opportunities (GHLO) Homepage. Available at: http://www.aamc.org/services/ghlo/. Accessed Oct 1, 2013.
11. Peluso M, Encandela J, Hafler J, Margolis C. Guiding principles for the development of global health education curricula in undergraduate medical education. Med Teach. 2012; 34:653–8.
12. Redwood-Campbell L, Pakes B, Rouleau K, et al. Developing a curriculum framework for global health in family medicine: emerging principles, competencies, and educational approaches. BMC Med Educ. 2011; 11:46.
13. Bozorgmehr K, Saint V, Tinnemann P. The "global health" education framework: a conceptual guide for monitoring, evaluation, and practice. Global Health. 2011; 7:8.
14. Rowson M, Smith A, Hughes R, et al. The evolution of global health teaching in undergraduate medical curricula. Global Health. 2012; 8:35.
15. Haq C, Rothenberg D, Gjerde C, et al. New world views: preparing physicians in training for global health work. Fam Med. 2000; 32:566–72.
16. Abedini NC, Gruppen LD, Kolars JC, Kumagi AK. Understanding the effects of short-term international service-learning trips on medical students. Acad Med. 2012a; 87:820–8.
17. Thompson MJ, Huntington MK, Hunt DD, Pinsky LE, Brodie JJ. Educational effects of international health electives on U.S. and Canadian medical students and residents: a literature review. Acad Med. 2003; 78:242–7.

18. Francis ER, Goodsmith N, Michelow M, et al. The global health curriculum of Weill Cornell Medical College: how one school developed a global health program. Acad Med. 2012; 87:1296–302.
19. Broom JL, Gordon JK, Victory FL, Clarke LA, Goldstein DA, Emmel ND. International health in medical education: students' experiences and views. J Health Organ Manag. 2007; 21:575–9.
20. Heck JE, Pust R. A national consensus on the essential international health curriculum for medical schools. Acad Med. 1993; 68:596–8.

Cross Ref, Pub Med, CAS, Web of Science® Times Cited: 13

21. Eckhert LN. Getting the most out of medical students' global health experiences. Ann Fam Med. 2006; 4(Suppl 1):S38–9.
22. International Federation of Medical Students' Associations-USA. The IFMSA-USA/GHEC Partnership: Curriculum Development in Global Health. Available at: http://www.docstoc.com/docs/430494/Developing-Global-Health-Curricula.
23. Houpt E, Pearson R, Hall T. Three domains of competency in global health education: recommendations for all medical students. Acad Med. 2007; 82:222–5.
24. Johnson O, Bailey SL, Willott C, Crocker-Buque T, Jessop V. Global health learning outcomes for medical students in the UK. Lancet. 2012; 379:2033–5.
25. Battat R, Seidman G, Chadi N, et al. Global health competencies and approaches in medical education: a literature review. BMC Med Educ. 2010; 10:94.
26. Hobgood C, Anantharaman V, Bandiera G, et al. International Federation for Emergency Medicine model curriculum for medical student education in emergency medicine. Int J Emerg Med. 2010; 3:1–7.
27. Merson MH, Page KC. The Dramatic Expansion of University Engagement in Global Health: Implications for US policy. Washington, DC: Center for Strategic & International Studies, 2009.
28. Peluso MJ, Forrestel AK, Hafler JP, Rohrbaugh RM. Structured global health programs in U.S medical schools: a web-based review of certificates, tracks and concentrations. Acad Med. 2013; 88:124–30.
29. UN Platform on Social Determinants of Health. Health in the Post-2015 Development Agenda: Need for a Social Determinants of Health Approach. Available at: http://www.who.int/social_determinants/advocacy/health-post-2015_sdh/en/index.html. Accessed Oct 1, 2013.
30. SOICH: Section on International Child Health. Global Health Curriculum Toolkit. http://www2.aap.org/sections/ich/toolkit.htm. Accessed April 20, 2013.
31. Arthur MA, Battat R, Brewer TF. Teaching the basics: core competencies in global health. Infect Dis Clin N Am. 2011; 25:347–58.
32. Gruppen LD, Mangrulkar RS, Kolars JC. The promise of competency-based education in the health professions for improving global health. Hum Resour Health. 2012; 10:43.
33. MedBiquitous Consortium. Performance Framework-Definitions. Available at: http://groups.medbiq.org/medbiq/display/CWG/Performance+ Framework+-+Definitions. Accessed Oct 1, 2013.
34. Murdoh-Eaton D, Green A. The contribution and challenges of electives in the development of social accountability in medical students. Med Teach. 2011; 33:643–8.

35. Stoltenberg M, Rumas N, Parsi K. Global health and service learning: lessons learned at US medical schools. Med Educ Online. 2012;17: doi: 10.3402/meo.v17i0.18848.
36. Abedini NC, Gruppen LD, Kolars JC, Kumagi AK. Understanding the effects of short-term international service-learning trips on medical students. Acad Med. 2012b; 87:820–8.
37. Kirkpatrick D. Evaluating Training Programs: The Four Levels. San Francisco, CA: Berrett-Koehler, 1994.
38. Ramsey AH, Haq C, Gjerde CL, Rothenberg D. Career influence of an international health experience during medical school. Fam Med. 2004; 36:412–6.
39. Sebelius KH. The Global Health Strategy of the U.S. Department of Health and Human Services 2011. Available at: http://www.globalhealth.gov/pdfs/Global%20Health%20Strategy.pdf. Accessed Oct 1, 2013.
40. Miller WC, Corey GR, Lallinger GJ, Durack DT. International health and internal medicine residency training: the Duke University experience. Am J Med. 1995; 99:291–7.
41. Gupta AR, Wells CK, Horwitz RI, Bia FJ, Barry M. The International Health Program: the fifteen-year experience with Yale University's Internal Medicine Residency Program. Am J Trop Med Hyg. 1999; 61:1019–23.
42. Bouri N, Sell TK, Franco C, Adalja AA, Henderson DA, Hynes NA. Return of epidemic dengue in the United States: implications for the public health practitioner. Public Health Rep. 2012; 127:259–66.
43. Stys D, Hopman W, Carpenter J. What is the value of global health electives during medical school? Med Teach. 2013; 35:209–18.
44. Grant J. Learning needs assessment: assessing the need. BMJ. 2002; 324:156–9.
45. Kraeker C, Chandler C. We learn from them, they learn from us: global health experiences and host perceptions of visiting health care professionals. Acad Med. 2013; 88:483–7.
46. Finch TH, Chae SR, Shafaee MN, et al. Role of students in global health delivery. Mt Sinai J Med. 2011; 78:373–81.
47. Crump JA, Sugarman J; Working group on Ethics Guidelines for Global Health Training (WEIGHT). Global health training: ethics and best practice guidelines for training experiences in global health. Am J Trop Hyg. 2010;83:1178–82.
48. Iserson K, Biros M, Holliman J. Challenges in international medicine: ethical dilemmas, unanticipated consequences, and accepting limitations. Acad Emerg Med. 2012; 19:683–92.

Keywords

- **Disaster response**
- **Emergency response**
- **Global health care**
- **International medicine**
- **Medical evacuation**
- **Mobile hospitals**
- **Predictive preventive personalized medicine**
- **Trauma**
- **Telemedicine**

Author Notes

Chapter 1

Competing Interests
The authors declare that they have no competing interests.

Authors' Contributions
Both authors contributed equally to the concept of disaster response centers and integrating disaster response into the ongoing healthcare delivery system. R J Andrews composed the draft of the manuscript, which was reviewed and edited by L M Quintana. Both authors read and approved the final manuscript.

Chapter 2

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Competing Interests
I have read the journal's policy and have the following conflicts: MG declares no competing interests. MC is a founder and current Director of Evidence Aid. CA is employed as Knowledge Manager for Evidence Aid. BK is employed as Coordinator for Evidence Aid. WS is a member of the Evidence Aid Advisory Board. DD is a member of the Evidence Aid Advisory Board. MM is a member of the Evidence Aid Advisory Board. PS declares no competing interests. AG declares no competing interests. RZ declares no competing interests. SG is a member of the Evidence Aid Advisory Board. VB is Medicine Editorial Director, PLOS; and a member of the Evidence Aid Advisory Board. VM is an editor of PLoS Currents Disasters and employed in the UK as the Head of Extreme Events and Health Protection at Public Health England. VM is actively engaged as part of her work to build a better evidence base for preparedness, response,

and recovery to extreme events. VM is the Vice-Chair of the UNISDR Science and Technical Advisory Group where they are working to show that science is useful, usable, and used for disaster risk reduction. VM is a member of the Evidence Aid Advisory Board. JvS declares no competing interests.

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Author Contributions
Wrote the first draft of the manuscript: MG. Contributed to the writing of the manuscript: MG, MC, CA, BK, WS, DD, MM, PS, AG, RZ, SG, VB, VM, JvS. ICMJE criteria for authorship read and met: MG, MC, CA, BK, WS, DD, MM, PS, AG, RZ, SG, VB, VM, JvS. Agree with manuscript results and conclusions: MG, MC, CA, BK, WS, DD, MM, PS, AG, RZ, SG, VB, VM, JvS.

Chapter 4

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Competing Interests
The authors declare that they have no competing interests.

Authors' contributions
SZ and GF designed the study and developed the questionnaire. SZ, LW, LZX and YLZ supervised the data collection and data entry process. SZ performed data checkup, data analysis and drafted the manuscript. All authors participated in writing, revision and approval of the final manuscript.

Chapter 5

Competing Interests
The authors declare that they have no competing interests.

Authors' Contributions
MR, SF, AG, JT, NK, JW, JB and JD contributed to the conception and design of the study. MR, SF, JT, AG and NK collected the data; MR, SF, AG, JT, NK,

JW and JB contributed to the analysis and interpretation of data. MR, SF, JT, AG, JB, JW and JD were involved in drafting the manuscript. All authors were involved in revising the manuscript critically for important intellectual content. All authors have given final approval of the version to be published.

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Chapter 9

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Chapter 10

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Author Contributions
Both authors contributed to the development of the questionnaire, the conduct of the interviews, the analysis of the data, and the writing of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest.

Chapter 11

Limitations
The authors recognize certain limitations to the study. We acknowledge that the response rate to the pre-conference questionnaire and participation in the conference didactic session was limited and may introduce a component of selection bias. We also recognize that some of the recommendations of the consensus conference include participation and partnership with other professional Emergency Medicine organizations.

Competing Interests
The authors declare that they have no competing interests.

Authors' Contribution
JPT: Study concept and design; acquisition of the data; analysis and interpretation of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; statistical expertise; obtained funding; administrative, technical and material support; study supervision. CB, KA, BH: Study concept and design; analysis and interpretation of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content. DC: Study concept and design; analysis and interpretation of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; study supervision. GBK: Study concept and design; administrative, technical and material support; analysis and interpretation of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

Chapter 12

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Authors' Contributions

TE, participated in manuscript concept and design. AS, participated in manuscript concept and design. DS, manuscript concept and design. TM, critical revision of article. DD, provided critical revision of article. EG, provided critical revision of article. All authors read and approved the final manuscript.

Chapter 13

Limitations

The disaster nursing competencies standard delineated by ICN, and referenced by all nurses worldwide, was adopted as the framework to evaluate the perceived competencies of nurses in Hong Kong for disaster. The categorization of key competencies reported by nurses align with the ICN framework of disaster nursing competencies may be arbitrary, but was merely a practical way to estimate the nurses' level of competencies, further research is needed to identify nurses' competent level in meeting the needs for disaster nursing. This study focused on nurses from three specialties may not be generalizable to other nurses and further study is needed to include other nurses from other specialties.

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Author Contributions

Alice Yuen Loke and Olivia Wai Man Fung both have substantial contributions to conception and design, Olivia Wai Man Fung for acquisition of data, Olivia Wai Man Fung and Alice Yuen Loke analysis and interpretation of data together; Olivia Wai Man Fung drafting the article, Alice Yuen Loke revising it critically for important intellectual content; and both Alice Yuen Loke and Olivia Wai Man Fung approved the final version submitted for published.

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The authors declare no conflict of interest.

Index

D

G

H

I

N

O

P

Q

R

S

T