Resource-Poor Settings: Infrastructure and Capacity Building
Care of the Critically Ill and Injured During Pandemics and Disasters: CHEST Consensus Statement

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BACKGROUND: Planning for mass critical care (MCC) in resource-poor or constrained settings has been largely ignored, despite their large populations that are prone to suffer disproportionately from natural disasters. Addressing MCC in these settings has the potential to help vast numbers of people and also to inform planning for better-resourced areas.

METHODS: The Resource-Poor Settings panel developed five key question domains; defining the term resource poor and using the traditional phases of disaster (mitigation/preparedness/response/recovery), literature searches were conducted to identify evidence on which to answer the key questions in these areas. Given a lack of data upon which to develop evidence-based recommendations, expert-opinion suggestions were developed, and consensus was achieved using a modified Delphi process.

RESULTS: The five key questions were then separated as follows: definition, infrastructure and capacity building, resources, response, and reconstitution/recovery of host nation critical care capabilities and research. Addressing these questions led the panel to offer 33 suggestions. Because of the large number of suggestions, the results have been separated into two sections: part 1, Infrastructure/Capacity in this article, and part 2, Response/Recovery/Research in the accompanying article.

CONCLUSIONS: Lack of, or presence of, rudimentary ICU resources and limited capacity to enhance services further challenge resource-poor and constrained settings. Hence, capacity building entails preventative strategies and strengthening of primary health services. Assistance from other countries and organizations is needed to mount a surge response. Moreover, planning should include when to disengage and how the host nation can provide capacity beyond the mass casualty care event.

ABBREVIATIONS: MCC = mass critical care; MDG = Millennium Development Goal; NGO = nongovernmental organization; WHO = World Health Organization
Summary of Suggestions

**Definition**

1. We suggest the term “resource poor or constrained setting” defines a locale where the capability to provide care for life-threatening illness is limited to basic critical care resources, including oxygen and trained staff. It may be stratified by categories: No resources, limited resources, and limited resources with possible referral to higher capability.

2. We suggest “critical care in a resource poor or constrained setting” be defined by the provision of care for life-threatening illness without regard to the location, including the pre-hospital, emergency, hospital wards, and intensive care setting.

**Infrastructure and Capacity Building**

3. We suggest in order to provide quality critical care, at any capability level, resource limited countries or health-care bodies should strengthen their primary care, basic emergency care, and public health systems.

4. We suggest capacity building in public health include education for families, community health-care workers, and clinicians in addition to infrastructure support such as transportation and communication systems.

5. We suggest developing countries strive to build capacity by leveraging critical care expertise and resources that exist in such disciplines as surgery, obstetrics, internal medicine, and pediatrics.

6. In order to support those countries with limited critical care assets, we suggest professional critical care societies in resource-rich, developed countries and clinical settings in addition to infrastructure support such as transportation and communication systems.

7. We suggest investment in critical care education and development of processes where limited resources can be applied to those patients most likely to benefit from the interventions.

7a. We suggest such processes explore innovative staffing methods and preventative and supportive care that decreases critical illness.

**Building Capacity and Quality in District Hospitals:**

8. We suggest performance improvement activities be instituted at district or regional level facilities and information shared such that other ICUs and hospitals can learn from one another.

9. We suggest, where feasible, that surgical capacity of the district or regional hospital build capacity to optimize surgical volumes and maintain skills in order to reduce preventable morbidity and mortality.

**Emergency Care and Triage:**

10. In order to mitigate the need for critical care, we suggest the development of simple triage tools, protocols, and care guidelines modified to resource limitations that can be used by health workers with limited clinical backgrounds. This education should include the IMCI (Integrated Management of Childhood Illness) and IMAI (Integrated Management of Adolescent and Adult Illness) guidelines for recognition, triage, and treatment of the critically ill in resource limited areas.

**Prehospital Care and Transport:**

11. We suggest education and training of resuscitation, evacuation, and transport of the critically ill be a priority for providers.
11a. We suggest expanding pre-hospital support in the community through education of medical and non-medical laypersons.

Strategic Planning to Build Capacity:
12. We suggest developing countries or settings that are chronically resource constrained develop a minimal level of critical care to be provided at district or regional hospital facilities.

12a. We suggest critical care advocates involve administrators, financiers, nongovernmental organizations (NGOs), and other similar stakeholders to provide resources to expand capacity to meet such minimal levels.

13. We suggest focusing limited emergency and critical care resources at facilities where the greatest benefit can be achieved. Although basic resuscitation capabilities must exist at all levels, rather than developing rudimentary critical care at primary health clinics, district or regional hospitals may be the most effective and efficient areas of focus to improve national critical care capabilities.

External Alliances:
14. We suggest local authorities establish formal relationships with coalitions of academic medical centers, professional societies, NGO’s, and governmental organizations prior to an actual event in disaster-prone, resource poor regions.

We suggest these partnerships have the following objectives:

1. To develop and maintain effective communication with the goal of assessing the need for assistance and planning for training, logistics, and timetable for the delivery of support;
2. To help implement relief efforts, including schedule rotations for teams in and out of the disaster affected areas; and,
3. To develop planning and preparation for potential disaster events based on historical experience within each region. Such planning should include resolving issues related to licensure and liability coverage in addition to resource allocation and training.

Current Resource Allocation During Crises:
15. We suggest critical care providers use protocols to combine workable approaches that are also cost effective and efficient.

16. We suggest feasibility plans of a protracted event requiring long-term use of critical care resources be developed, whereby the health-care system will require a coordination between less resource-intense but large numbers of primary care patients in concert with resource-intense but fewer critical care patients.

Laboratory Services:
17. We suggest the establishment and implementation of national laboratory strategic plans and policies that integrate existing laboratory systems to combat major prevalent infectious diseases.

Engagement of Staff:
18. In order to engage a motivated workforce to provide critical care, we suggest several initiatives:

1. Making data readily available
2. Using data to inform subsequent interventions that can promote change in resource-poor settings
3. Acquiring or attempting to garner additional resources with government support including affordable and sustainable technologies
4. Engaging local leadership to encourage staff and motivate buy-in

World Health Organization Resources:
19. We suggest an international body such as the United Nations or World Health Organization (WHO) develop a Relief Coordination Center to aid the evaluation and coordination of international disaster response with use of prepositioned, stored emergency materials and teams.

20. We suggest the WHO develop a Pocket Book of Acute/Critical Care for Hospitalized Patients to help standardize expectations and medical practice.

Introduction
Planning for mass critical care (MCC) in resource-limited settings has been largely ignored, despite large populations who live in crowded conditions and who are prone to suffer disproportionately from natural disasters. In these settings, crisis standards of care are a daily reality. Thus, addressing MCC in these settings has the potential to benefit large populations and also inform planning in better-resourced areas. All stages of planning should involve clinicians, administrators and the public. Decisions made have grave implications and
should always include ethicists in all stages (see “Ethical Considerations” article by Daugherty Biddison et al in this consensus statement). Given this background, the Resource-Poor Settings panel of the Task Force for Mass Critical Care defined the setting and outlined suggestions for capacity building and mitigation, preparedness, response, and reconstitution and recovery. This article focuses on defining the setting and preparatory actions prior to a disaster event. Many of the capability building and mitigation suggestions in this article are relevant to policy makers and health administrators, whereas preparedness and response primarily relate to clinicians. However, the suggestions inevitably rely on close working relationships and should be read by both clinicians and policy makers. In addition, an approach that works well in one country may work less well in another, and not all approaches are equally acceptable to all governments or their multiple constituencies. There is no one blueprint for an ideal health-care system, nor are there any magic bullets that will automatically elicit improved performance. This is hardly surprising: healthcare systems are complex social systems, and the success of any one approach will depend on the system into which it is intended to fit as well as on its consistency with local values and ideologies. In fact, the need to modify World Health Organization (WHO) protocols and the need to work cooperatively within an integrated model with local authorities, especially when local infrastructure is even partially intact, is highlighted by the recent experience with Typhoon Yolanda in the Philippines. Thus, how these suggestions are implemented is best left to the local authorities. The second article, “Resource-Poor Settings: Response, Recovery, and Research,” by Geiling et al in this consensus statement examines events following a disaster and future research opportunities.

Materials and Methods
The Resource-Poor Settings panel developed five key question domains, and literature searches were conducted to identify an evidence base on which to answer the key questions (see e-Appendix 1 for search terms and literature results if sufficient evidence found). Searches were limited to 2007 to 2013; English-language and non-English-language papers were included. Given the lack of data upon which to develop evidence-based recommendations, expert-opinion suggestions were developed, with consensus achieved using a modified Delphi process. Full details regarding the methodology are provided elsewhere in this supplement (see “Methodology” article by Ornelas et al in this consensus statement).

Results
Definition

1. We suggest the term “resource poor or constrained setting” defines a locale where the capability to provide care for life-threatening illness is limited to basic critical care resources, including oxygen and trained staff. It may be stratified by categories:

- No resources, limited resources, and limited resources with possible referral to higher care capability.

2. We suggest “critical care in a resource poor or constrained setting” be defined by the provision of care for life-threatening illness without regard to the location, including the pre-hospital, emergency, hospital wards, and intensive care setting.

Throughout this article “a developing country” refers to both developing or underdeveloped countries. The peer-reviewed literature on critical care in the developing world is predominantly descriptive in nature. Nevertheless, it supports the view that the current status of services is too often rudimentary, unaffordable, and complex. The presence or absence of critical care resources indirectly defines the differences between “have and have not” populations in many developing countries (Fig 1). Currently, even rapidly emerging economies, such as India, China, and Indonesia, still harbor the largest proportion of the world’s “bottom billion” living in poverty. The peer-reviewed literature suggests that in the developing world, many critical care services for the bulk of the population are similar to the services seen in the Western world in the 1950s and 1960s, with limited monitoring and treatment capabilities and high patient-to-nurse staffing ratios. The situation is even worse in resource-poor countries, where progress has been painfully slow and difficult to maintain and has often slipped back or disappeared because of many barriers external to health, such as war, conflict, economic strife, and health-care workforce crises.

In the developed world, critical care services usually involve “a coordinated system of triage, emergency management and Intensive Care Units (ICUs)” providing contemporary and standards of care to the population. Unfortunately, in many developing countries, critical care services are constrained because of limited human and material resources. Thus, hospital
In developing countries, an ICU often consists of pressurized air or oxygen but rarely any mechanical ventilation or renal replacement therapy. Although ICU services in some university and private hospitals in South Africa, Uganda, Kenya, Rwanda, and Namibia are comparable to Western countries, in township and district hospitals ICU care is often nonexistent. What can be found at the district hospital level is a four- to eight-bed ICU with one or two nurses and nothing else. Fifty percent of the patients will have an empty IV drip and no patient monitors, mechanical ventilators, necessary disposable materials (EEG stickers, tubing, and so forth), or electricity. Oxygen is rare because refilling cylinders or electric oxygen concentrators generally do not exist. Lack of ICU services is also found in South and East Asia and the Pacific Islands.

Nevertheless, critically ill patients clearly exist in these countries and may benefit from timely care even in settings without ICUs. Critical care in resource-poor settings is defined, therefore, by the provision of care to the critically ill regardless of location or the availability of intensive care services.

Infrastructure and Capacity Building

3. We suggest in order to provide quality critical care, at any capability level, resource limited countries or health-care bodies should strengthen their primary care, basic emergency care, and public health systems.

4. We suggest capacity building in public health include education for families, community health-care workers, and clinicians in addition to infrastructure support such as transportation and communication systems.

Published recommendations emphasize improving primary care, prevention, and basic emergency care where possible. A study of 30 low-income countries with the highest average daily reduction of mortality of children following the 1978 Declaration of Alma-Ata showed that a committed, prioritized, and phased primary health-care investment was cost effective and led to achieving the Millennium Development Goals (MDGs). Developing primary health facility-specific preparedness plans also strengthened the preventive response to future disasters. Advances in care should move incrementally without compromising primary care resources. Using personnel,
materials, and health-system infrastructure creatively can cost-effectively optimize the provision of emergency care in resource-poor settings. Researchers and decision-makers should promote the case for universal access to emergency care and research agendas to fill the gaps in knowledge. Obstacles to developing effective emergency medical care include a lack of structural models, inappropriate training foci, and concerns about cost and sustainability in the face of a high demand for services.

5. We suggest developing countries strive to build capacity by leveraging critical care expertise and resources that exist in such disciplines as surgery, obstetrics, internal medicine, and pediatrics.

Severe shortages of primary care providers, specialists, nurses, and prehospital-care providers are present today in about 60 developing countries. Logistic and financial limitations, as well as poorly resourced supporting disciplines (e.g., laboratories, radiology, nursing), poor general health status of patients, and delayed presentation of severely sick patients to the ICU also contribute to comparatively high mortality. Where critical care is available, the most common reasons for admission are for postsurgical treatment, including trauma, infectious diseases, and peripartum maternal or neonatal complications. These conditions are major contributors to the global burden of disease, and, hence, building critical care capacity around the relevant disciplines (e.g., surgery, obstetrics, pediatrics, and internal medicine) will enhance everyday care and lead to a more robust response to pandemics and disasters.

6. In order to support those countries with limited critical care assets, we suggest professional critical care societies in resource-rich, developed countries should advocate broadly to mitigate the intellectual siphoning of critical care providers from resource-poor countries.

The intellectual siphoning of critical care providers from resource-poor to resource-rich countries exacerbates the health-care worker crisis in many countries. Critical care professionals in the developed nations also have a duty to avoid damaging the health-care systems of resource-poor countries by advocating against such intellectual siphoning of their health-care professionals.

7. We suggest investment in critical care education and development of processes where limited resources

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Figure 2 – A, Progression of care in developed countries leading from established community level public health and emergency services in support of both secondary and tertiary level critical care services. B, The reality of conditions in many resource-poor countries, where basic emergency and protective public health services are lacking or nonexistent. Where critical care services are available, they are limited primarily to urban academic medical centers. ACLS = Advanced Cardiac Life Support; APLS = Advanced Pediatric Life Support; ATLS = Advanced Trauma Life Support; PALS = Pediatric Advanced Life Support; PICU = pediatric ICU; WHO = World Health Organization.
can be applied to those patients most likely to benefit from the interventions.

7a. We suggest such processes explore innovative staffing methods and preventative and supportive care that decreases critical illness.

Education clearly has a role to play in developing a sufficiently large pool of health-care professionals to meet demand. However, education should be context specific. With little prospect of the return or retention of physicians, the WHO has placed increasing emphasis on task sharing and training of nonspecialist physicians, nurses, and nonphysician clinicians to perform surgery or other skill sets. The issues of what and how to teach are equally important, because the first world mass casualty incident training does not necessarily account for challenges in developing countries. Simulation training provides an opportunity to engage learners regardless of language and cultural barriers and has been found especially useful in introducing primary triage and culturally sensitive treatments. Simulation training, telemedicine, and internet courses are useful adjuncts for training and evaluating humanitarian health workers, but they have not yet been explored as an educational tool for the indigenous populations.

Building Capacity and Quality in District Hospitals:

8. We suggest performance improvement activities be instituted at district or regional level facilities and information shared such that other ICUs and hospitals can learn from one another.

Emphasis in developing countries is placed on district hospitals, which serve as the hub of hospital care for surrounding primary care clinics, typically referring more complex, specialty care needs to national or academic centers. Unfortunately, the inefficiencies of the district hospitals is considerably high and may negatively affect the government’s initiatives to improve access to quality health-care interventions that are necessary to achieve the health-related MDGs. Modeling and learning from best practices are crucial. Inefficient hospitals must learn from their efficient peers to improve the overall performance of the health system.

9. We suggest, where feasible, that surgical capacity of the district or regional hospital build capacity to optimize surgical volumes and maintain skills in order to reduce preventable morbidity and mortality.

A comprehensive countrywide assessment of surgical capacity in resource-limited settings found severe shortages in available resources. For example, in Rwanda, <10% of the country can claim adequate surgical services, including trained anesthesia providers, reliable electricity, running water, generators, pulse oximetry, and life-saving surgical airway equipment. A recent study of surgical, anesthetic, and obstetric capacities in 78 government district hospitals in seven low-income countries (Bangladesh, Bolivia, Ethiopia, Liberia, Nicaragua, Rwanda, and Uganda) highlighted the lack of trained staff and adequate equipment and suggested that surgery and safe anesthesia must be prioritized within global health. Increasing surgical capacity will address unmet surgical needs, and higher volumes will bolster surgical skills and the ability to provide care in disasters. Thus, surgical capacity of the district hospital should be significantly expanded.

Emergency Care and Triage:

10. In order to mitigate the need for critical care, we suggest the development of simple triage tools, protocols, and care guidelines modified to resource limitations that can be used by health workers with limited clinical backgrounds. This education should include the IMCI (Integrated Management of Childhood Illness) and IMAI (Integrated Management of Adolescent and Adult Illness) guidelines for recognition, triage, and treatment of the critically ill in resource limited areas.

Emergency care, including triage, is often one of the weakest parts of the health system in resource-poor settings, but if well organized it can be life-saving and cost effective. In a wide range of settings, patient populations and systems (eg, inpatient children, multidisciplinary providers, emergency triage assessment and treatment, transport training, poisoning, evaluation of urban triage, nurses trained in triage, experience-based realities, simplified protocols, and treatment algorithms have resulted in reduced morbidity and mortality.

Prehospital Care and Transport:

11. We suggest education and training of resuscitation, evacuation, and transport of the critically ill be a priority for providers.

11a. We suggest expanding pre-hospital support in the community through education of medical and non-medical laypersons.

High risk of worsening morbidity and mortality exists during the transport process in settings of personnel and resource limitations. Education and training of appropriate resuscitation, proper evacuation, and safe
transport of the critically ill, including obstetrical emergencies from rural birthing centers, are a priority.\textsuperscript{34,52,53}

**Strategic Planning to Build Capacity:**

12. We suggest developing countries or settings that are chronically resource constrained develop a minimal level of critical care to be provided at district or regional hospital facilities.

12a. We suggest critical care advocates involve administrators, financiers, NGOs, and other similar stakeholders to provide resources to expand capacity to meet such minimal levels.

Emergency and critical care may be improved by defining the minimum standard of care as the level of care that ought to be delivered under conditions of appropriate and efficient referral in a national system. However, the moral argument may be made in some circumstances for an even higher level of care.\textsuperscript{34} For example, in pandemics, an incremental advancement of emergency and critical care capacity may be realized over time. Strategic planning should focus on personnel, training, equipment support services, ethics, and research.\textsuperscript{16} These settings also require the iterative introduction of service improvements that leverage human resources through training, focus on sustainable technology, continually analyze cost effectiveness, and share context-specific best practices.\textsuperscript{54} The strategic planning process must engage senior managers and front-line practitioners and publicize the strategic process throughout the public and the hospital, where formal challenges to the reasoning process are encouraged.\textsuperscript{55}

13. We suggest focusing limited emergency and critical care resources at facilities where the greatest benefit can be achieved. Although basic resuscitation capabilities must exist at all levels, rather than developing rudimentary critical care at primary health clinics, district or regional hospitals may be the most effective and efficient areas of focus to improve national critical care capabilities.

Most district hospitals face challenges in providing complex critical care, and hence those resources typically lie at regional or national hospitals.\textsuperscript{6,22,36} However, internal country assistance from those regional hospitals can also be valuable, an example of which occurred during the second wave of the 2009 influenza A(H1N1) pandemic in Mexico. There, larger hospitals sent support teams with health personnel and equipment to ill-equipped and inexperienced areas, thereby improving their training to standardize processes and the clinical care of the patients.\textsuperscript{56}

**External Alliances:**

14. We suggest local authorities establish formal relationships with coalitions of academic medical centers, professional societies, NGO’s, and governmental organizations prior to an actual event in disaster-prone, resource poor regions. We suggest these partnerships have the following objectives:

1. To develop and maintain effective communication with the goal of assessing the need for assistance and planning for training, logistics, and timetable for the delivery of support;

2. To help implement relief efforts, including schedule rotations for teams in and out of the disaster affected areas; and,

3. To develop planning and preparation for potential disaster events based on historical experience within each region. Such planning should include resolving issues related to licensure and liability coverage in addition to resource allocation and training.

Academic medical centers in the developed world may be able to provide disaster support for an extended time to underserved areas, including countries with austere resources at baseline, with little significant impact on their own operations.\textsuperscript{27,58} This support can be accomplished by using their own clinical departments and by partnering with similar like-minded institutions. A long on-site presence allows for integration of the responding teams into the local community, permits continuity of care, provides enough time to coordinate replacement teams, and facilitates a transition of responsibility to the local medical community. Humanitarian efforts in unfamiliar territory can result in misappropriation of resources due to poor communication, misunderstanding of resources, and needs.\textsuperscript{59,60}

**Resources Necessary to Enhance Capacity**

**Current Resource Allocation During Crises:**

15. We suggest critical care providers use protocols to combine workable approaches that are also cost effective and efficient.

Recent crises, such as the 2009 A(H1N1) influenza pandemic, emphasize the need for bulk antiviral medications, oxygen concentrators, and pulse oximetry monitoring in developing countries. Using pulse oximetry in resource-poor health facilities to target oxygen therapy is likely to save costs, and these devices can be shared between patients by trained technicians. Novel practices, such as the use of ultrasound devices to
3. Acquiring or attempting to garner additional resources with government support including affordable and sustainable technologies.

4. Engaging local leadership to encourage staff and motivate buy-in.

Key areas of consideration in building critical care in developing countries settings include personnel and training, equipment and support services, and ethics. Basic care processes, such as monitoring vital signs, administering medications, and laboratory testing, if performed unreliably, may result in treatment delays owing to lack of information needed for clinical decision-making. Lack of information may also hinder advocacy for resources and effective and efficient care. Making data visible and using data to inform subsequent interventions, lobbying for resources, and involving local leadership are essential for success, thereby encouraging staff and motivating their engagement.

Ethical decision-making and human resource decisions must be based on data when possible and always on transparent, articulated policies to quantify improvements necessary for meeting MDGs for priority setting for all institutions.

World Health Organization Resources:
19. We suggest an international body such as the United Nations or WHO develop a Relief Coordination Center to aid the evaluation and coordination of international disaster response with use of prepositioned, stored emergency materials and teams.

In acute crises, appropriate rapid crisis intervention could be achieved by ongoing global disaster surveillance by a Relief Coordination Center served by a panel of experts who would evaluate and coordinate the international disaster response and make use of stored emergency material and emergency teams. Successful disaster response depends on accurate and relevant medical intelligence and socio-geographical mapping in advance of, during, and after the event(s) causing the disaster. A first step in preparing for a pandemic in developing countries involves building capacity in public health surveillance and proven community containment and mitigation strategies.

During pandemics, resource-poor settings are more vulnerable for many reasons, but it is universally accepted that surveillance must take priority.

20. We suggest the WHO develop a Pocket Book of Acute/Critical Care for Hospitalized Patients to help standardize expectations and medical practice.

The WHO has previously developed a field-tested toolkit to guide the care of children. We suggest the WHO complement this existing pocket book with a similar Pocket Book of Acute/Critical Care for the Hospitalized
Patient. Additional competency-based education and training is available through mechanisms such as the Educational Committee of the World Federation of Societies of Intensive and Critical Care Medicine. The World Health Assembly Resolution 60.22, “Health Systems: Emergency Care Systems,” serves as a policy tool for improving emergency care and availability globally.

Areas for Future Research/Interventions/ Limitations

In resource-poor areas, advocacy for resources to provide basic emergency and minimum critical care services should be undertaken. Research should be directed to preventative measures, such as social distancing, as well as to implementation and improvement projects on ways to build capacity for mass casualties and pandemics. Efforts should be expended to adjust guidelines to complement the available resources. Partnerships should be formed to participate in joint exercises simulating likely scenarios. Underlying these efforts, efficacy must be measured and validated, with limited resources targeted to those practices that save lives, time, and resources.

Conclusions

Resource-poor settings offer a unique challenge to the provision of MCC to vulnerable victims. However, by better defining those at risk, we can begin to explore mechanisms to not only respond but also build greater capacity and resilience, and then, following the event, rebuild or even expand health-care capabilities. The suggestions proposed in this document are not a defined set of proposals meant to serve as a gold standard. Rather, they serve as a starting point to help those at risk and those responding to help in such resource-constrained settings and situations. Only through the pursuit of active research, training, and effective measurement of outcomes can these suggestions be improved to better care for disaster and pandemic victims in resource-poor settings.

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Additional information: The e-Appendix is available in the Supplemental Materials section of the online article.

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