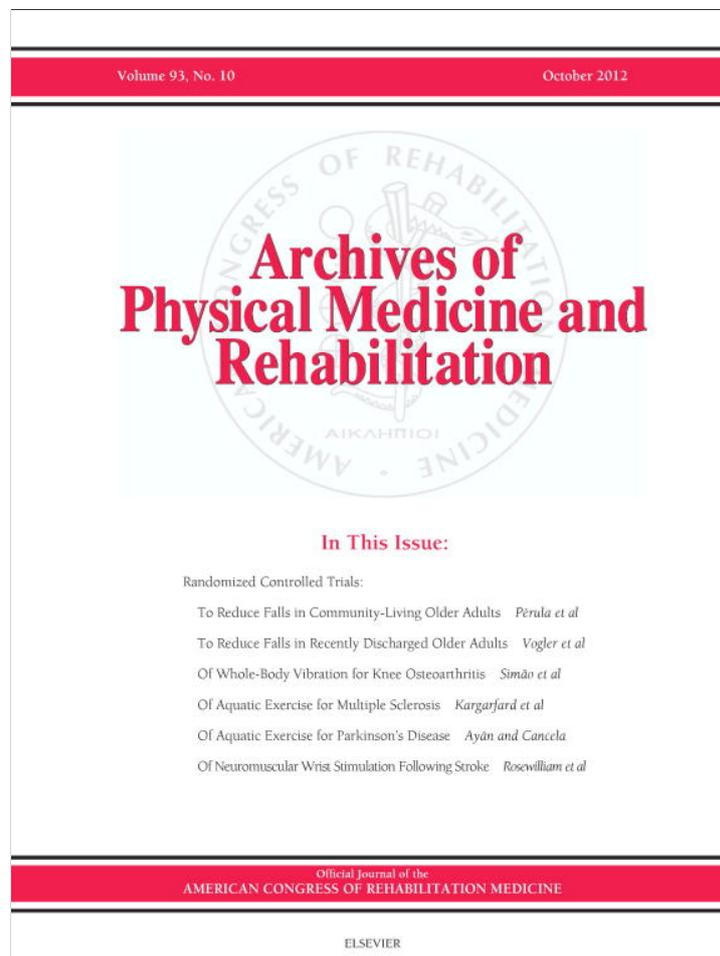


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## SPECIAL COMMUNICATION

# Medical Rehabilitation After Natural Disasters: Why, When, and How?

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**ABSTRACT.** Rathore FA, Gosney JE, Reinhardt JD, Haig AJ, Li J, DeLisa JA. Medical rehabilitation after natural disasters: why, when, and how? *Arch Phys Med Rehabil* 2012;93:1875-81.

Natural disasters can cause significant numbers of severe, disabling injuries, resulting in a public health emergency and requiring foreign assistance. However, since medical rehabilitation services are often poorly developed in disaster-affected regions and not highly prioritized by responding teams, physical and rehabilitation medicine (PRM) has historically been underemphasized in global disaster planning and response. Recent development of the specialties of "disaster medicine" and "disaster rehabilitation" has raised awareness of the critical importance of rehabilitation intervention during the immediate postdisaster emergency response. The World Health Organization Liaison Sub-Committee on Rehabilitation Disaster Relief of the International Society of Physical and Rehabilitation Medicine has authored this report to assess the role of emergency rehabilitation intervention after natural disasters based on current scientific evidence and subject matter expert accounts. Major disabling injury types are identified, and spinal cord injury, limb amputation, and traumatic brain injury are used as case studies to exemplify the challenges to effective management of disabling injuries after disasters. Evidence on the effectiveness of disaster rehabilitation interventions is presented. The authors then summarize the current state of disaster-related research, as well as lessons learned from PRM emergency rehabilitation response in recent disasters. Resulting recommendations for greater integration of PRM services into the immediate emergency disaster response are provided. This report aims to stimulate development of research and practice in the emerging discipline of disaster rehabilitation

within organizations that provide medical rehabilitation services during the postdisaster emergency response.

**Key Words:** Amputation; Disability evaluation; Disasters; Occupational therapy; Outcome assessment; Rehabilitation; Spinal cord injuries.

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**T**HE INTERNATIONAL SOCIETY of Physical and Rehabilitation Medicine (ISPRM) is an international professional rehabilitation society that has defined evaluating and expanding the role of medical rehabilitation in disaster management as a priority agenda item.<sup>1</sup> At its 5th World Congress (Istanbul, Turkey, 2009), the ISPRM Board of Governors commissioned a report on the role of emergency rehabilitation intervention after natural disasters. The World Health Organization (WHO) Liaison Sub-Committee on Rehabilitation Disaster Relief (CRDR) was also officially formed at this meeting. Committee members have prepared this report that summarizes the role and experience of physical and rehabilitation medicine (PRM) and the ISPRM CRDR in the emergency humanitarian medical response to large-scale natural disasters. The desired outcome is increased integration of PRM perspective into the immediate emergency disaster response. While this is an internal planning document, it is hoped that other rehabilitation organizations and the greater PRM and disaster medicine communities will find it informative and useful for their respective purposes.

Specifically, the aims of this report are as follows:

- To provide an overview of PRM conditions in natural disasters
- To outline challenges in the management of disabling conditions during the immediate emergency disaster response using the examples of spinal cord injuries (SCIs), limb amputations, and traumatic brain injuries (TBIs)
- To summarize the current state of disaster-related research
- To summarize lessons learned from the PRM emergency rehabilitation response experience based on the medical literature and subject matter expert accounts
- To provide recommendations for the role of PRM during the emergency response to future large-scale natural disasters

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## List of Abbreviations

CRDR	Sub-Committee on Rehabilitation Disaster Relief
DART	Disability Acute Rehabilitation Team
ISPRM	International Society of Physical and Rehabilitation Medicine
NGO	nongovernmental organization
PRM	physical and rehabilitation medicine
PWD	person with disability
SCI	spinal cord injury
TBI	traumatic brain injury
WHO	World Health Organization

Manmade disasters, disabling injury types beyond those addressed herein, and medical needs of persons with preexisting disabilities other than acute exacerbation of their conditions and new-onset disabling injuries are beyond the scope of this report and require further attention in future documents. In addition, technological disasters and complex humanitarian emergencies have associated rehabilitation needs, but the added complexity of these disaster types requires separate investigation. Also, the role and experience of allied rehabilitation providers and other professional rehabilitation organizations are not emphasized.

Large-scale disasters often become public health emergencies that result in significant loss of life, limb, and property. General classification of disasters subsumes "natural disasters" (biologic, geologic, or climatic), "technological disasters" such as nuclear accidents, or "complex humanitarian emergencies" including civil wars. A natural disaster is defined by the WHO as a "sudden ecological disruption or threat that exceeds adjustment capacity of the affected community and requires external assistance."<sup>2(p11),3</sup> Common types of natural disasters include earthquakes, floods, hurricanes, tsunamis, volcanic eruptions, and fires.

The sudden onset and great magnitude of large-scale natural disasters, especially earthquakes, often result in significant numbers of victims with severe disabling injuries including long bone fractures, limb amputations, SCIs, TBIs, crush injuries, burns, and peripheral nerve injuries.<sup>4-7</sup> The severely disrupted local medical infrastructure including supporting communication and transportation networks is immediately overwhelmed, compromising medical response and management of the severely injured.

Injury patterns, mortality profiles, and economic impact of natural disasters have been well researched and documented.<sup>4-8</sup> Lessons learned and collective experience have been integrated into comprehensive disaster management plans designed to minimize the loss of human lives and reduce survivor morbidity.<sup>9-11</sup> The perspective of the medical community in the health care response is increasingly reflected in disaster planning.<sup>12</sup> Regrettably, however, response plans and acute care protocols do not typically include rehabilitation interventions, resulting in neglected acute rehabilitative need. Medical complications of disabling injuries, long-term disability, and other significant, negative consequences for the individual and society are the result.<sup>13</sup> Although physiatrist involvement during the immediate emergency disaster response would result in more optimal management of new-onset traumatic disabling injuries, recognition of the physiatrist's role and participation in international disaster response is not widespread. Moreover, natural disasters mostly occur in low-resource regions of the world where rehabilitation services are either underdeveloped or do not exist.<sup>14,15</sup>

## METHODS

Current best evidence on disaster rehabilitation was obtained from an electronic and manual search of the scientific literature supplemented by subject matter expert commentary including CRDR member accounts. The electronic search (1950–2011; English language only) was performed using the Medline, Science Direct, OVID, Springerlink, Google Scholar, Scopus, and CINAHL databases. Key words were *disasters, rehabilitation, disability, functional outcome, disaster response, disaster management, epidemiology, persons with disability, spinal cord injury, traumatic brain injury, fractures, peripheral nerve injuries, complications, physical therapy, occupational therapy, orthotics, prosthetics, earthquake, tsunami, hurricane, floods, and low-resource countries*. Many CRDR members are

physiatrists who have themselves provided medical rehabilitation services in disasters including the Sidr cyclone in Bangladesh and Hurricane Katrina in the United States, as well as earthquakes in Turkey, Iran, Pakistan, China, and Haiti.

## RESULTS

### Magnitude of the Problem: PRM Conditions and Preexisting Disabilities in Disasters

Natural disasters result in injuries requiring rehabilitation that vary based on the type of disaster and its magnitude, the geography of the affected area, the dynamics of the impacted population, and the situation of the individual victim. Documented major impairments include long bone fractures, limb amputations, SCIs, TBIs, and peripheral nerve injuries.<sup>6,15-23</sup> Minor impairments include conditions such as swollen feet and legs, leg pain, muscle pulls and cramps, tendonitis/fasciitis, and musculoskeletal pain.<sup>24,25</sup>

Persons with preexisting disabilities can incur acute exacerbation of chronic disabling conditions, as well as new-onset disabling injuries, and are at increased risk of injury and death in a disaster.<sup>26</sup> They face increased barriers to accessible emergency information (especially those with sensory deficits), are often unable to evacuate from the disaster zone by available means because of a lack of accessible transportation or other requisite assistance, and have difficulty accessing shelter services, including medical care. Local evacuation plans generally fail to meet transportation needs of persons with disabilities (PWDs) because planners are mostly unaware of their presence in the community and fail to realize that PWDs have special evacuation needs. This places this vulnerable population at an increased risk of developing additional disabilities, worsening of the preexisting disability, and increased risk of mortality if their needs are not addressed in a timely fashion.

### Management Challenges for Disabling Conditions in the Immediate Disaster Response: Case Studies of SCI, Limb Amputation, and TBI

SCI is considered the prototype disabling condition because of its complex medical management and need requirements; yet, SCI victims are "the most neglected of all patients injured in an earthquake."<sup>27(p373)</sup> A person with newly acquired SCI requires early, coordinated evacuation from the disaster zone via specialized transfer and transport protocols to minimize worsening of the injury and mortality.<sup>28</sup> Responders, including family members and neighbors, paramedical health professionals, and physicians without SCI expertise, attempt to care for these persons despite lacking the required training and skills.<sup>29,30</sup> Consequently, although lives may be saved, medical complications are increased, and functional improvements as well as long-term survival are often compromised.<sup>28,31</sup> Since proper management in local health care facilities is not feasible, onward transfer to tertiary centers for definitive management (conservative vs surgical) and specialized care (including skin, bowel, and bladder protocols) by rehabilitation professionals is indicated. SCI management without physiatrist involvement may result in inaccurate initial assessment, unsafe evacuation, prolonged hospital admission, and unrealistic counseling for long-term prognosis. Additional negative consequences can include insufficient patient and caregiver education, inadequate pain management, inappropriate prescription of mobility aids, and even death from untreated complications such as urinary tract infections and pressure ulcers after discharge.<sup>28,30,31</sup>

Limb amputation is another disabling condition resulting from catastrophic natural disasters that warrants early physia-

trist involvement. Hundreds to thousands of traumatic and surgical amputations may result,<sup>26,32</sup> requiring emergent wound management and rehabilitation of the residual limb. Effective management will facilitate timely hospital discharge, freeing urgently required hospital beds<sup>33</sup> and optimizing future prosthetic fitting. Physiatrists ideally become involved before amputation and educate the surgical team on prosthetic considerations.<sup>34</sup>

During a disaster, the physiatrist can offer an amputee the following pre-, peri-, and postoperative services, which if not addressed, can have severe adverse consequences:

- Preamputation planning and consultation to the surgical team (on adequate length, shape, and soft tissue cover of the residual limb)
- Wound management and application of compression bandaging
- Shaping of the residual limb
- Management of residual limb or phantom limb pain
- Prosthesis prescription compatible with patient mobility status, vocational expectation, and living environment
- Patient education and counseling

Victims with TBI also benefit from physiatrist involvement after the disaster. Patients are usually hemodynamically stable and therefore evacuated from the disaster zone to definitive care after most patients with fractures and amputations.<sup>33</sup> Many are managed in temporary facilities while awaiting transfer and are at increased risk for secondary conditions including contractures, pressure ulcers, urinary tract infections, aspiration pneumonia, malnutrition, and rapid cognitive dysfunction. Physiatrists can prevent and effectively manage most of these conditions,<sup>33</sup> preserving long-term functional outcomes. Early multidisciplinary rehabilitation is associated with better TBI outcomes,<sup>35,36</sup> which are generally maintained at long-term follow-up.<sup>37</sup>

Besides victims with severe TBI and craniocerebral trauma, a significant number of persons sustain mild TBI in disasters. However, most do not receive a diagnosis of mild TBI because they do not seek care and are not clinically recognized in the chaotic disaster environment. Most persons with mild TBI recover well with adequate follow-up and patient counseling without requiring additional intervention.<sup>38</sup> Some, however, are completely disabled and require a comprehensive care plan to prevent complications and deterioration.

### Current State of Disaster-Related Research

The lack of systematic and standardized data collection during disasters from the past leads to a major weakness of current disaster-related research.<sup>39</sup> For example, an estimated 15% of the world population has some form of disability (18% for the low-income countries),<sup>40</sup> but the estimates for PWDs residing in camps or temporary shelters after disasters are only 5% to 7%.<sup>41</sup> Current trends in medical decision making dictate that one should strive to obtain the highest level of scientific evidence while proposing new interventions and management plans. The obvious flaw in this logic is that it results in policies regarding what is easy to study, rather than policies that address the most important interventions.

Since criterion standard randomized controlled trials are not feasible in the postdisaster setting, the best evidence available on the effectiveness of rehabilitation interventions after disasters are from quasiexperimental or observational studies using cross-sectional as well as prospective and retrospective designs (surveys). Recent studies of Sichuan earthquake survivors with fractures and SCI showed the effectiveness of postdisaster rehabilitation interventions as demonstrated by improved long-

term functional outcomes and quality of life, for example. Hospital series and case reports provide descriptive epidemiologic data on disabling injury diagnoses for which rehabilitation is indicated. Responding medical team mission reports, although commonly indexed in the gray literature, can provide useful information as well. In addition, opinions of subject matter experts with firsthand experience in disaster rehabilitation are valuable, although not evidence based.

Notwithstanding study design limitation, lack of systematic, standardized data collection during disasters has limited the range and quality of available disaster-related research.<sup>40,41</sup> Disasters by nature allow little time for research planning, and frequently no supporting baseline demographic data are readily available in low-resource regions; on-site medical records are typically incomplete and of limited use.<sup>42</sup> Since the priority for medical response beyond initial triage and resuscitation is stabilization of traumatic disabling injuries, descriptive rehabilitation needs assessment for service delivery planning is the immediate research priority. Although a baseline patient functional assessment would also ideally occur, limitations of measurement tools and assessment team priorities in the chaotic, postdisaster environment may be prohibitive. Unfortunately, population needs and individual functional status field-based assessment, though critical, has not been conducted historically.

### Rehabilitation Interventions After Disasters: Experience Around the Globe and Lessons Learned

Experience from the Pakistan, Sichuan (China), and Haiti earthquakes, as well as Hurricane Katrina (United States), has demonstrated the value of providing rehabilitation services as part of the immediate emergency medical response.<sup>15,28,43,44,45</sup> In Pakistan, a group of PRM faculty and residents supervised the management and rehabilitation of a large number of victims with SCI with good results. Patients had reduced complications and hospital lengths of stay, as well as better outcomes, compared with centers with no physiatrist involvement.<sup>15,28</sup>

After the Sichuan earthquake, a rapid, military-led national response resulted in efficient onward transfer of critically injured persons, including those with SCI, to hospitals across 20 provinces using special trains and chartered flights—the greatest long-distance peacetime transfer of patients in China.<sup>44</sup> The shortage of trained rehabilitation professionals was addressed by mobilizing professionals from other parts of the country, training hospital staff in rehabilitation principles and practices by an international rehabilitation services nongovernmental organization (NGO), and inviting foreign experts to provide additional training.<sup>43,45</sup> Follow-up of SCI and fracture victims (at 1y and 27mo, respectively) from the Sichuan earthquake showed significant effectiveness of rehabilitation intervention.<sup>46,47</sup> Improved activities of daily living and other functional outcomes, reduced complications, and better health-related quality of life were demonstrated. Increased awareness of rehabilitation intervention was noted in the 2008 Sichuan earthquake compared with the Tangshan earthquake of 1976.<sup>46</sup>

Large numbers of disabilities were reported after the Indian Ocean tsunami in 2004 and the Sidr cyclone (Bangladesh) in 2008. Rehabilitation teams engaged quickly and effectively managed patients with major and minor disabilities sustained in these cataclysmic tropical storms.<sup>48,49</sup> Rehabilitation teams comprising physiatrists,<sup>50</sup> physical therapists<sup>51,52</sup> occupational therapists, orthotists, and prosthetists successfully provided rehabilitation services to amputees, as well as victims with SCI and TBI, in the recent earthquake in Haiti, resulting in in-

creased societal acceptance of medical rehabilitation and development of long-term rehabilitation infrastructure.

Significant lessons learned from the literature review and expert commentary on emergency PRM interventions after large-scale natural disasters are as follows:

- Large numbers of disabling injuries normally occur in natural disasters and require comprehensive medical management including rehabilitation interventions.
- Most disasters occur in low-resource world regions where rehabilitation services are poorly developed,<sup>14,15</sup> and the burden of new-onset, traumatic disabling conditions quickly overwhelms and depletes available rehabilitation services.
- Medical rehabilitation is an urgent, essential emergency medical service in disasters and not restricted to the intermediate and long-term care settings. Early physiatrist involvement in complex orthopedic and neurologic trauma has shown to be of benefit in nondisaster trauma. Immediate rehabilitation services postdisaster are likely to reduce morbidity, improve functional outcomes, and improve survival.<sup>15,31,46,50</sup>
- Physiatrist participation in the immediate emergency disaster response has proved effective in managing disabling injuries including fractures, amputation, SCI, and TBI, among others. Physiatrists prevent and treat related medical complications, establish pain management protocols, and arrange for appropriate postdischarge follow-up. Physiatrists also provide valuable pre-, peri-, and postoperative consultation.
- Physiatrists' understanding of patients' comprehensive medical needs, including rehabilitation, can compensate for the relative lack of rehabilitation expertise on a responding medical team.<sup>33</sup>
- Postdisaster rehabilitation reduces hospital length of stay, freeing critical medical resources.
- Postdisaster rehabilitation results in faster medical recovery, fewer complications, and greater improvement of functional outcomes. Improved outcomes, in turn, contribute to greater social integration and community participation, which help build postdisaster society (as opposed to expending limited health and social services).
- Emergency rehabilitation services should only be provided by trained, credentialed professionals to ensure practice accountability and proper standards of care. Nonqualified personnel, although well intentioned, should provide care only in the event of extreme emergency and under strict supervision.
- Effective coordination of organizations providing rehabilitation services after a disaster, including national and international NGOs, is required to efficiently allocate human and material resources to provide optimal, comprehensive rehabilitative care to the impacted population.
- Selection and development of functional assessment tools appropriate to disaster-related research, especially during the emergency response, are needed.

## RECOMMENDATIONS

Recommendations based on our review and lessons learned are as follows:

1. **Develop scientific evidence for medical rehabilitation in the emergency disaster response:** High-quality scientific evidence supporting medical rehabilitation as part of the immediate emergency medical response to natural disasters will convince the PRM and disaster medicine communities of the critical importance of rehabilitation intervention. Data collection should begin as early as possible and be

repeated at intervals to assess therapeutic intervention over patients' continuum of care. Intervention costs must be documented to evaluate their cost-effectiveness and to monetize rehabilitation programming as well as the overall burden of disability. Suggested elements of a disaster rehabilitation research strategy during the emergency response are as follows:

- a. **Measure the burden of disability after disasters:** International disaster data sets similar to the SCI data sets<sup>53</sup> and *International Classification of Functioning, Disability and Health* core sets<sup>54</sup> could be developed. These data sets would inform the systematic collection of data on patterns of injury, types of disabilities, and related functional deficits. Data sets should be sufficiently comprehensive and simple to administer.
  - b. **Document functional outcomes:** Documentation of functional status in the newly injured would guide timely, appropriate rehabilitation therapy. Some traditional measures such as the FIM are not field friendly, requiring well-trained staff and a relatively long administration time.<sup>33</sup> Simpler scales such as the Barthel Index<sup>55</sup> or Language Independent Functional Evaluation<sup>56</sup> should be used instead. Also, measure design constraints such as ceiling and floor effects must be considered in modeling rehabilitation effectiveness.<sup>57</sup> An *International Classification of Functioning, Disability and Health*-based needs assessment tool assessing level of functioning, corresponding rehabilitation need, and required rehabilitation expertise was successfully piloted in the Haiti earthquake.<sup>58</sup>
2. **Develop and host rehabilitation disaster relief expertise:** The ISPRM and other rehabilitation professional societies should provide specialized training on rehabilitation disaster relief and facilitate member participation in related service opportunities. Suggested plan elements are as follows:
    - a. **Develop a training program in rehabilitation disaster relief:** Training in the policy and practice of disaster rehabilitation will provide physiatrists with added qualifications to guide their deployment participation. The ISPRM CRDR is currently developing an online curriculum (for its Disability Acute Rehabilitation Team [DART] program) (table 1) that includes general humanitarian aid principles and rehabilitation-specific provider competencies to instruct physiatrists in providing rehabilitative management of persons with disabling injuries during the immediate disaster response. This course incorporates the Sphere Minimum Standards in Humanitarian Response for injury care during disasters<sup>59</sup> and the Global Health Cluster Foreign Medical Team Health Services Checklist.<sup>60</sup>
    - b. **Establish a subject matter expert database:** Establishing an ISPRM member rehabilitation database will facilitate deployment of physiatrists and other rehabilitation professionals in support of international rehabilitation disaster relief efforts. The database will facilitate timely volunteer deployment as a result of preregistration and verification of providers' preferences and qualifications. Database access procedures would allow timely pairing of volunteers with requesting agencies including governments, NGOs, and United Nations agencies. As an example, the United Kingdom International Emergency Trauma Register was recently launched to help address international

**Table 1: Proposed DART Curriculum**

<p>Planning ahead</p> <ul style="list-style-type: none"> <li>● Developing clinical flexibility and coverage</li> <li>● Financing travel</li> <li>● Assembling a team of responders</li> <li>● Equipment and supplies to bring</li> </ul> <p>Acutely</p> <ul style="list-style-type: none"> <li>● Engaging the emergency response leaders</li> <li>● Working with nongovernmental agencies</li> <li>● Basics of acute trauma medicine</li> <li>● Rehab for rescuers—spinal cord evacuation, etc</li> <li>● Surveying and reporting the needs</li> <li>● Acute rehab triage and management</li> <li>● Discharge planning from day of admission</li> </ul> <p>Subacute</p> <ul style="list-style-type: none"> <li>● Working with the local team</li> <li>● Working with the emergency rehab team</li> <li>● Measuring prevalence of disability</li> <li>● Developing a sustainable program</li> <li>● Dealing with the media</li> <li>● Getting donors</li> </ul> <p>Personal survival</p> <ul style="list-style-type: none"> <li>● When not to go</li> <li>● Licensure and visa</li> <li>● Protection from the disaster</li> <li>● Protection from rioting and crime</li> <li>● Emotional protection/reentry</li> </ul>
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Abbreviation: rehab, rehabilitation.

surgical emergency needs.<sup>61</sup> Related, the World Confederation of Physical Therapy has recently established a “database of experts” designed to share member knowledge and expertise.<sup>62</sup> The ISPRM database could thus serve multiple purposes as a repository of disaster rehabilitation expertise. The ISPRM subject matter expert database is an activity on the current WHO/ISPRM collaborative work plan.

3. **Develop an international rehabilitation emergency response capability:** A field-deployable rehabilitation re-

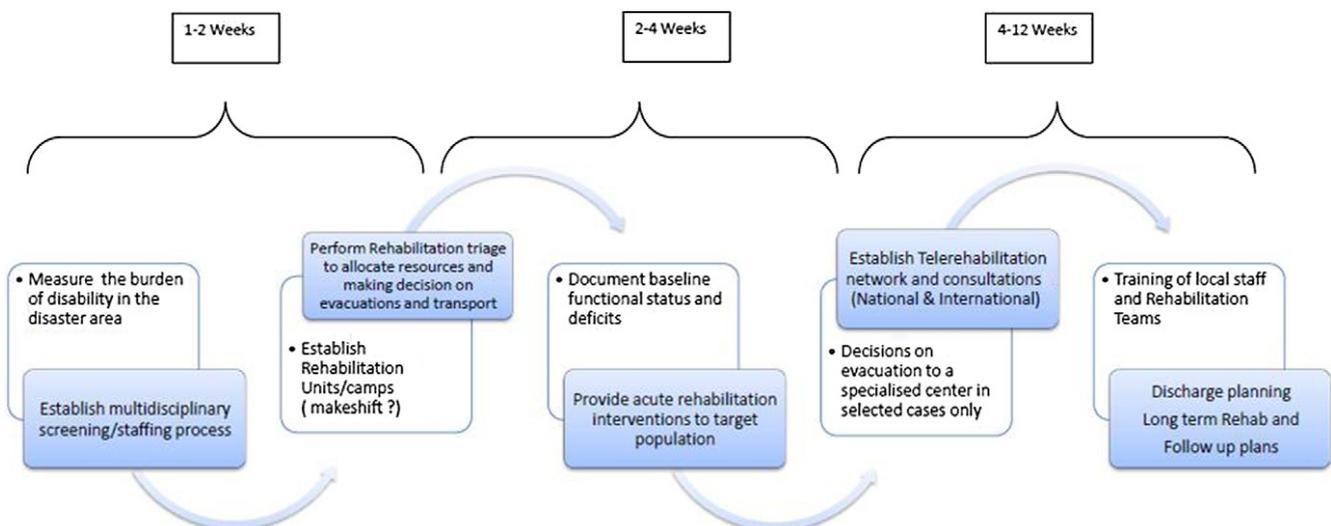
sponse capability in the form of a PRM team could insert physiatrists into a disaster area during the immediate emergency health response, providing psychiatric expertise during this critical period. Teams of varying composition could perform multiple missions, including the following:

- Rehabilitation needs assessment and other research
- Direct patient management and consultation as part of a medical/surgical team
- Implementation of telerehabilitation capability
- Rehabilitation training of other providers
- Rehabilitation resource coordination for the disaster management structure

Roles and responsibilities would change as the disaster response evolves (fig 1). PRM team practice would subscribe to Global Health Cluster guidance for foreign medical teams.<sup>62</sup> Recognizing this critical need, the ISPRM is currently developing a DART. Table 1 outlines the proposed program curriculum during the emergent and postemergent phases of response, as well as advance planning considerations and responder survival measures.

International NGOs involved in medical rehabilitation after disasters should actively coordinate across all levels and phases of response with the United Nations Inter-Agency Standing Committee/WHO Global Health Cluster planning and guidance. NGO participation in development of response guidance, strategy review, and field coordination will help ensure an optimal disaster rehabilitation response.

4. **Develop a PRM disaster response capability in low-resource regions:** Building a PRM disaster response capability in low-resource regions is critical to improving the global disaster rehabilitation response since most catastrophic natural disasters occur in these areas characterized by minimal rehabilitation medicine infrastructure and poor disaster planning. The ISPRM CRDR could coordinate with PRM national societies via ISPRM WHO regional representatives to establish national society disaster committees. Committees would partner with local and national disaster authorities to develop a rehabilitation disaster response infrastructure that would strengthen local response capability and also facilitate the international response depending on the scale of the disaster. Regardless, reduced



**Fig 1. A suggested plan of rehabilitation interventions after a natural disaster. Abbreviation: rehab, rehabilitation.**

morbidity and mortality because of the rehabilitation provided for traumatic disabling conditions would predictably result. Online posting of country-specific, disaster-related policies, procedures, and training supplemented by related funded educational travel would be facilitative.

5. **Develop a telerehabilitation consultation process:** Major aid agencies should consider funding and developing a telerehabilitation consultation process. It is not possible for the members of a standard multidisciplinary team to cover all disaster-affected areas. Development of telerehabilitation consultation processes involving distant experts (physicians and allied health professionals) where certain expertise is missing or in rural or isolated communities would be invaluable. It is important that local and international telerehabilitation services and liaisons be established, so that the expertise can be shared on a wider scale.

In addition, a mobile rehabilitation facility (similar to a mobile surgical team) can be used to provide medical rehabilitation in disaster zones where there were no PRM services or the centers have been damaged. A mobile orthopedic workshop successfully provided prostheses in the Haiti earthquake.<sup>63</sup>

### CONCLUSIONS

Medical rehabilitation is an essential part of the immediate emergency health response in a large-scale natural disaster. This report proposes recommendations for advancing rehabilitation in disasters that will be developed by the ISPRM CRDR into specific implementation strategies with supporting actions. Partner organizations that also provide global disaster rehabilitation services are also encouraged to develop and share their expertise in order to more effectively integrate PRM perspective into the global disaster rehabilitation response.

Physiatrists can help in the postacute disaster phase by offering their expertise in the prevention of pressure ulcers, positioning techniques, prevention of thromboembolism, management of SCI and TBI, prevention of the debilitating effects of prolonged immobility after major injuries, and pre-, peri-, and postoperative consulting. It is important that physiatrists be consulted in disaster response plans and their expertise used earlier rather than later when preventable complications have already occurred.

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### References

1. Stucki G, von Groote PM, DeLisa JA, et al. Chapter 6: the policy agenda of ISPRM. *J Rehabil Med* 2009;41:843-52.
2. Lechat MF. Disasters and public health. *Bull World Health Organ* 1979;57:11-7.
3. World Health Organization. Emergency care in natural disasters: views of an international seminar. *WHO Chron* 1980;34:96-100.
4. Athukorala P, Resosudarmo BP. The Indian Ocean Tsunami: economic impact, disaster management, and lessons. *Asian Econ Papers* 2005;4:1-39.
5. Sami F, Ali F, Zaidi SH, Rehman H, Ahmad T, Siddiqui MI. The October 2005 earthquake in Northern Pakistan: patterns of injuries in victims brought to the Emergency Relief Hospital, Doraha, Mansehra. *Prehosp Disaster Med* 2009;24:535-9.
6. Mateen FJ. Neurological disorders in complex humanitarian emergencies and natural disasters. *Ann Neurol* 2010;68:282-94.
7. Centers for Disease Control and Prevention (CDC). Post-earthquake injuries treated at a field hospital—Haiti, 2010. *MMWR Morb Mortal Wkly Rep* 2011;59:1673-7.
8. Farfel A, Assa A, Amir I, et al. Haiti earthquake 2010: a field hospital pediatric perspective. *Eur J Pediatr* 2011;170:519-25.
9. Roy N. The Asian Tsunami: PAHO disaster guidelines in action in India. *Prehosp Disaster Med* 2006;21:310-5.
10. Bremer R. Policy development in disaster preparedness and management: lessons learned from the January 2001 earthquake in Gujarat, India. *Prehosp Disaster Med* 2003;18:372-84.
11. Yokohama strategy and plan of action for a safer world: guidelines for natural disaster prevention, preparedness and mitigation. World Conference on Natural Disaster Reduction; 1994 May 23-27; Yokohama, Japan. Available at: <http://www.ifrc.org/Docs/idrl/I248EN.pdf>. Accessed May 5, 2012.
12. Brandeau ML, McCoy JH, Hupert N, Holty JE, Bravata DM. Recommendations for modeling disaster responses in public health and medicine: a position paper of the Society for Medical Decision Making. *Med Decis Making* 2009;29:438-60.
13. Gosney J, Reinhardt JD, Haig AJ, Li J. Developing post-disaster physical rehabilitation: role of the World Health Organization Liaison Sub-Committee on Rehabilitation Disaster Relief of the International Society of Physical and Rehabilitation Medicine. *J Rehabil Med* 2011;43:965-8.
14. Haig AJ, Im J, Adewole D, Nelson V, Krabak B. The practice of physical and rehabilitation medicine in sub-Saharan Africa and Antarctica: a white paper or a black mark? *J Rehabil Med* 2009;41:401-5.
15. Rathore MF, Rashid P, Butt AW, Malik AA, Gill ZA, Haig AJ. Epidemiology of spinal cord injuries in the 2005 Pakistan earthquake. *Spinal Cord* 2007;45:658-63.
16. Dai ZY, Li Y, Lu MP, Chen L, Jiang DM. Clinical profile of musculoskeletal injuries associated with the 2008 Wenchuan earthquake in China. *Ulus Travma Acil Cerrahi Derg* 2010;16:503-7.
17. Zhang L, Li H, Carlton JR, Ursano R. The injury profile after the 2008 earthquakes in China. *Injury* 2009;40:84-6.
18. Bai XD, Liu XH. Retrospective analysis: the earthquake-injured patients in Barakott of Pakistan. *Chin J Traumatol* 2009;12:122-4.
19. Bhatti SH, Ahmed I, Qureshi NA, Akram M, Khan J. Head trauma due to earthquake October, 2005—experience of 300 cases at the Combined Military Hospital Rawalpindi. *J Coll Physicians Surg Pak* 2008;18:22-6.
20. Mulvey JM, Awan SU, Qadri AA, Maqsood MA. Profile of injuries arising from the 2005 Kashmir earthquake: the first 72 h. *Injury* 2008;39:554-60.
21. Ahrari MN, Zangiabadi N, Asadi A, Sarafi Nejad A. Prevalence and distribution of peripheral nerve injuries in victims of Bam earthquake. *Electromyogr Clin Neurophysiol* 2006;46:59-62.
22. Tezzoni LI, Ronan LJ. Disability legacy of the Haitian earthquake. *Ann Intern Med* 2010;152:812-4.
23. Phalkey R, Reinhardt JD, Marx M. Injury epidemiology after the 2001 Gujarat earthquake in India: a retrospective analysis of injuries treated at a rural hospital in the Kutch district immediately after the disaster. *Glob Health Action* 2011;4:7196.
24. Chiou-Tan FY, Bloodworth DM, Kass JS, et al. Physical medicine and rehabilitation conditions in the Astrodome clinic after hurricane Katrina. *Am J Phys Med Rehabil* 2007;86:762-9.
25. Pang HN, Lim W, Chua WC, Seet B. Management of musculoskeletal injuries after the 2009 western Sumatra earthquake. *J Orthop Surg (Hong Kong)* 2011;19:3-7.
26. IRIN Global. Haiti: emergency sheds light on needs of pre-quake disabled. Available at: <http://www.irinnews.org/report.aspx?Reportid=90484>. Accessed May 19, 2012.

27. Umer M, Rashid H, Zafar H, Majeed K. Earthquake relief experience of Aga Khan University trauma team. *J Pak Med Assoc* 2006;56:370-4.
28. Rathore FA, Farooq F, Muzammil S, New PW, Ahmad N, Haig AJ. Spinal cord injury management and rehabilitation: highlights and shortcomings from the 2005 earthquake in Pakistan. *Arch Phys Med Rehabil* 2008;89:579-85.
29. Butt BA, Bhatti JA, Manzoor MS, Malik KS, Shafi MS. Experience of makeshift spinal cord injury rehabilitation center established after the 2005 earthquake in Pakistan. *Disaster Med Public Health Prep* 2010;4:8-9.
30. Rathore FA, Gill ZA, Muzammil S. A comment on management of spinal injuries in the October 2005 Pakistan earthquake. *Disaster Med Public Health Prep* 2011;5:174-5.
31. Rathore MF, Farooq F, Butt AW, Gill ZA. An update on spinal cord injuries in October 2005 earthquake in Pakistan. *Spinal Cord* 2008;46:461-2.
32. Mallick M, Aurakzai JK, Bile KM, Ahmed N. Large-scale physical disabilities and their management in the aftermath of the 2005 earthquake in Pakistan. *East Mediterr Health J* 2010;16:S98-105.
33. Reinhardt JD, Li J, Gosney J, et al. Disability and health-related rehabilitation in international disaster relief. *Glob Health Action* 2011;4:7191.
34. Knowlton LM, Gosney JE, Chackungal S, et al. 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* 2011;26:438-48.
35. Andelic N, Bautz-Holter E, Ronning P, et al. Does an early onset and continuous chain of rehabilitation improve the long-term functional outcome of patients with severe traumatic brain injury? *J Neurotrauma* 2012;29:66-74.
36. Zhu XL, Poon WS, Chan CC, Chan SS. Does intensive rehabilitation improve the functional outcome of patients with traumatic brain injury (TBI)? A randomized controlled trial. *Brain Inj* 2007;21:681-90.
37. Sander AM, Roebuck TM, Struchen MA, Sherer M, High WM Jr. Long-term maintenance of gains obtained in postacute rehabilitation by persons with traumatic brain injury. *J Head Trauma Rehabil* 2001;16:356-73.
38. Turner-Stokes L, Disler PB, Nair A, Wade DT. Multi-disciplinary rehabilitation for acquired brain injury in adults of working age. *Cochrane Database Syst Rev* 2005;(3):CD004170.
39. Sapir DG, Below R. Collecting data on disasters: easier said than done. *Asian Disaster Manage News* 2006;12:9-10.
40. Disability: a global picture. In: Officer A, Posarac A, editors. *World report on disability*. 2011. p 21-54. Available at: [http://whqlibdoc.who.int/publications/2011/9789240685215\\_eng.pdf](http://whqlibdoc.who.int/publications/2011/9789240685215_eng.pdf). Accessed June 14, 2012.
41. WHO, Department of Injuries and Violence Prevention. *Disasters, disability and rehabilitation*. Available at: [http://www.who.int/violence\\_injury\\_prevention/other\\_injury/disaster\\_disability2.pdf](http://www.who.int/violence_injury_prevention/other_injury/disaster_disability2.pdf). Accessed May 19, 2012.
42. Killian LM. An introduction to methodological problems of field studies in disasters. In: Stallings RA, editor. *Methods of disaster research*. Philadelphia: Xlibris; 2002. p 21-49.
43. Li Y, Pan F, Li Y. Analysis of rehabilitation needs, measures taken, and their effectiveness for the wounded following the Wenchuan earthquake. *J Evid Based Med* 2009;2:258-64.
44. Chen J, Zhao W, Xian M, Lu J, Liang Z. Trans-province transfer of 10,373 patients injured in Wenchuan earthquake. *J Evid Based Med* 2009;2:270-6.
45. He HC, Chen P, Liu SX, Lei ZJ, Yang YH, He CQ. The Urgent Rehabilitation Technique Education Program for Wenchuan earthquake victims. *Hong Kong J Emerg Med* 2011;18:324-7.
46. Zhang X, Hu X, Reinhardt JD, et al. Functional outcomes and health-related quality of life in fracture victims 27 months after the Sichuan earthquake. *J Rehabil Med* 2012;44:206-9.
47. Hu X, Zhang X, Gosney JE, et al. Analysis of functional status, quality of life and community integration in earthquake survivors with spinal cord injury at hospital discharge and one-year follow-up in the community. *J Rehabil Med* 2012;44:200-5.
48. Bathla BS. Poster 146: the role of physical medicine and rehabilitation after an acute disaster situation: a case report. *Arch Phys Med Rehabil* 2005;86:E31.
49. Uddin MT. Rehabilitation in natural disaster affected people: Bangladesh experience [abstract]. *J Rehabil Med* 2008;(Suppl 46):24.
50. Landry MD, O'Connell C, Tardif G, Burns A. Post-earthquake Haiti: the critical role for rehabilitation services following a humanitarian crisis. *Disabil Rehabil* 2010;32:1616-8.
51. Physical therapists rehabilitate and rebuild in disaster zones. *World Confederation for Physical Therapy News* April 2010;1-3. Available at: <http://www.wcpt.org/node/33711>. Accessed May 19, 2012.
52. Nixon SA, Cleaver S, Stevens M, Hard J, Landry MD. The role of physical therapists in natural disasters: what can we learn from the earthquake in Haiti? *Physiother Can* 2010;62:167-71.
53. Krogh K, Perkas I, Stiens SA, Biering-Sørensen F. International bowel function basic spinal cord injury data set. *Spinal Cord* 2009;47:230-4.
54. Müller M, Stier-Jarmer M, Quittan M, Strobl R, Stucki G, Grill E. Validation of the comprehensive ICF Core Sets for patients in early post-acute rehabilitation facilities. *J Rehabil Med* 2011;43:102-12.
55. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? *Int Disabil Stud* 1988;10:64-7.
56. Haig AJ, Jayarajan S, Maslowski E, et al. Development of a language-independent functional evaluation. *Arch Phys Med Rehabil* 2009;90:2074-80.
57. Twisk J, Rijmen F. Longitudinal tobit regression: a new approach to analyze outcome variables with floor or ceiling effects. *J Clin Epidemiol* 2009;62:953-8.
58. Rauch A, Baumberger M, Moise FG, von Elm E, Reinhardt JD. Rehabilitation needs assessment in persons with spinal cord injury following the 2010 earthquake in Haiti: a pilot study using an ICF-based tool. *J Rehabil Med* 2011;43:969-75.
59. Sphere Project. *The sphere handbook: humanitarian charter and minimum standards in humanitarian response*. Available at: <http://www.sphereproject.org/handbook/>. Accessed May 19, 2012.
60. IASC and Global Health Cluster. *Coordination and registration of providers of foreign medical teams in the humanitarian response to sudden-onset disasters: a health cluster concept paper*. Available at: [http://www.who.int/hac/global\\_health\\_cluster/about/policy\\_strategy/fmt\\_concept\\_paper\\_27\\_May.pdf](http://www.who.int/hac/global_health_cluster/about/policy_strategy/fmt_concept_paper_27_May.pdf). Accessed May 19, 2012.
61. Redmond AD, O'Dempsey TJ, Taithe B. Disasters and a register for foreign medical teams. *Lancet* 2011;377:1054-5.
62. World Confederation for Physical Therapy. *Data base of experts*. Available at: <http://www.wcpt.org/experts>. Accessed May 19, 2012.
63. The Johanniter International Assistance. *Haiti: Long-term assistance to improve mobility*. Available at: <http://www.johanniter.de/die-johanniter/johanniter-unfall-hilfe/start/project-countries/central-and-south-america/haiti/>. Accessed June 14, 2012.