

# Systematic review of multidisciplinary rehabilitation in patients with multiple trauma

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**Background:** Multiple trauma is a cause of significant disability in adults of working age. Despite the implementation of trauma systems for improved coordination and organization of care, rehabilitation services are not yet routinely considered integral to trauma care processes.

**Methods:** MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature, Allied and Complementary Medicine, Physiotherapy Evidence Database, Latin American and Caribbean Literature on Health Sciences and Cochrane Library databases were searched up to May 2011 for randomized clinical trials, as well as observational studies, reporting outcomes of injured patients following multidisciplinary rehabilitation that addressed functional restoration and societal reintegration based on the International Classification of Functioning, Disability and Health.

**Results:** No randomized and/or controlled clinical trials were identified. Fifteen observational studies involving 2386 participants with injuries were included. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach assessed methodological quality as ‘poor’ in all studies, with selection and observer bias. Although patients with low functional scores showed improvement after rehabilitation, they were unable to resume their pretrauma level of activity. Their functional ability was significantly associated with motor independence on admission and early acute rehabilitation, which contributed to a shorter hospital stay. Injury location, age, co-morbidity and education predicted long-term functional consequences. Trauma care systems were associated with reduced mortality. The gaps in evidence include: rehabilitation settings, components, intensity, duration and types of therapy, and long-term outcomes for survivors of multiple trauma.

**Conclusion:** Rehabilitation is an expensive resource and the evidence to support its justification is needed urgently. The issues in study design and research methodology in rehabilitation are challenging. Opportunities to prioritize trauma rehabilitation, disability management and social reintegration of multiple injury survivors are discussed.

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## Introduction

Trauma is the main cause of significant disability in adults of working age, and on average 36 life-years are lost per trauma death<sup>1,2</sup>. According to the World Health Organization (WHO), trauma is associated with moderate to severe disability for over 45 million people each year worldwide<sup>1</sup>. Trauma, therefore, involves a large socioeconomic burden and has a significant impact on healthcare costs, due both to lost economic opportunity and

to the direct costs of treatment (medical and rehabilitation). The aggregate lifetime costs for all injured patients in the USA were estimated to be US \$158 billion in 2001<sup>2</sup>. In Australia, in 2000–2001, Australian \$4 billion was spent on trauma survivors<sup>3</sup>. In the UK, the cost to the National Health Service of treating major trauma is up to £0.4 billion per annum<sup>4</sup>.

Rehabilitation is defined as ‘a problem-solving educational process aimed at reducing disability and handicap

(participation) experienced by someone as a result of disease or injury<sup>5</sup>. The principal focus of rehabilitation is on reducing symptoms and limitations at the level of activity and participation, and includes personal and environmental factors. Trauma rehabilitation extends beyond acute injury or wound management, to reintegration of the patient into the home and community. The cognitive and neuropsychological sequelae of trauma are also well recognized<sup>2,6,7</sup>.

The trauma systems model enhances community health through an organized system of injury prevention, acute care and rehabilitation that is fully integrated into the public health system of a community<sup>8</sup>. Trauma care is multidisciplinary and provided along a continuum that includes all phases of care. Rehabilitation is often the longest and most difficult phase of the trauma care continuum for patients and families. However, few patients have access to optimal rehabilitation programmes owing to lack of political commitment for reform and financially supported infrastructure<sup>9</sup>, and fragmented healthcare systems<sup>10,11</sup>. Moreover, rehabilitation services tend to be constructed around specific patterns of injury or functional impairments; thus providing care for the complex needs of patients with multiple injuries can be challenging<sup>12</sup>. Similarly, most rehabilitation literature has examined interventions for specific trauma conditions (*Table S1* and references, supporting information); and few reviews have examined the effectiveness of multidisciplinary rehabilitation programmes for patients with multiple injuries.

The objective of this review was to identify studies reporting rehabilitation outcomes for patients with multiple trauma, especially the approaches that are effective (setting, intensity, type of rehabilitation) and the outcomes that are affected (function, social reintegration, work, quality of life (QoL)), in order to guide treating clinicians and identify gaps in current knowledge.

## Methods

### Search strategy

An electronic search of the Cochrane Central Register of Controlled Trials (CENTRAL) (Cochrane Library 2010, Issue 2), MEDLINE (1980 to May 2011), Embase (1980 to May 2011), the Cumulative Index to Nursing and Allied Health Literature (CINAHL; 1982 to May 2011), Allied and Complementary Medicine (AMED; 1985 to May 2011), Physiotherapy Evidence Database (PEDro; 1982 to May 2011) and Latin American and Caribbean Literature on Health Sciences (LILACS; 1982 to May 2011) databases was performed using combinations of multiple search terms

for three themes: poly/multiple trauma, rehabilitation (multidisciplinary) and outcome/recovery (search strategy available from authors). Publication bias was minimized by sourcing unpublished data where possible<sup>13</sup>. Bibliographies of papers identified were scrutinized, and authors and known experts in the field were contacted, seeking published and unpublished trials. Limits placed included English-language publication and inclusion of adults aged 18 years and above.

### Inclusion criteria

Studies that compared multidisciplinary rehabilitation intervention in multiple trauma survivors with routinely available local services or lower levels of intervention, or studies that compared multidisciplinary care in different settings or at different levels of intensity, were included. All randomized clinical trials (RCTs) and controlled clinical trials (CCTs; quasi-randomized and quasi-experimental designs with comparative controls – controlled before-and-after studies) were included. Whenever RCTs/CCTs were lacking, a search for relevant observational studies was conducted. Descriptive studies for effectiveness of rehabilitation were included to identify gaps in service provision. Severe trauma was defined as an Injury Severity Score (ISS) of 16 or above<sup>14</sup>.

### Exclusion criteria

Studies that compared unidisciplinary rehabilitation intervention, where only one discipline provided care to the patient with multiple trauma (for example physiotherapy only), or where therapies or modalities were unidisciplinary (for example gait training or hydrotherapy), or where the study focused on isolated trauma (for example burns only), were excluded.

### Outcome measures

All studies on multiple trauma that included outcome measures as defined by the WHO International Classification of Functioning, Disability and Health (ICF)<sup>15</sup>, such as addressing impairments (for example fractures, burns, muscle weakness, spasticity), disability (for example inability to ambulate, self-care or be continent) and/or participatory issues (family, work, driving) were included.

### Study selection

Two authors independently screened and shortlisted all abstracts and titles of studies identified by the search

strategy for inclusion and appropriateness based on the selection criteria. Each study was evaluated independently by authors. If necessary, the full text of the article was obtained for further assessment to determine whether the trial met the inclusion/exclusion criteria. If no consensus was reached regarding the possible inclusion/exclusion of any individual study, a final consensus decision was made by the third author. Further information about the complete description of the rehabilitation interventions from the trialists was obtained, where necessary.

### Data extraction

Data extraction was conducted by two authors independently, using a standard pro forma. The information obtained from all included studies was: publication date and country, study location, study design, sample size, demographics, trauma types, intervention and outcomes. Any discrepancies were resolved by both authors re-reviewing the study.

### Quality assessment of the included studies

Two authors independently assessed the risk of bias of included trials during data extraction according to the *Cochrane Handbook of Systematic Reviews of Interventions* (Chapter 8.5)<sup>16</sup>. A best-evidence synthesis was conducted based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodological quality of included studies from the domains: sequence generation; allocation concealment; blinding of participants, therapists and outcome assessors; incomplete outcome data; and selective outcome reporting. A judgement of 'yes' indicated a low risk of bias, 'no' a high risk of bias, and 'unclear' an unclear or unknown risk of bias.

Studies were considered to be of high methodological quality when the risk of bias for all domains was low. Studies were rated as of low methodological quality when there was an unclear or high risk of bias for one or more domains. Any disagreements in regard to methodological quality were resolved by the third author.

The GRADE approach is applicable to all types of study (including observational studies). For example, if observational studies yielded large effects and there was no obvious bias explaining those effects, the evidence could be rated as of moderate or even high quality if the effect was sufficiently large. On the other hand, studies with critical problems and unsystematic clinical observations could be downgraded to 'very low quality' studies.

### Statistical analysis

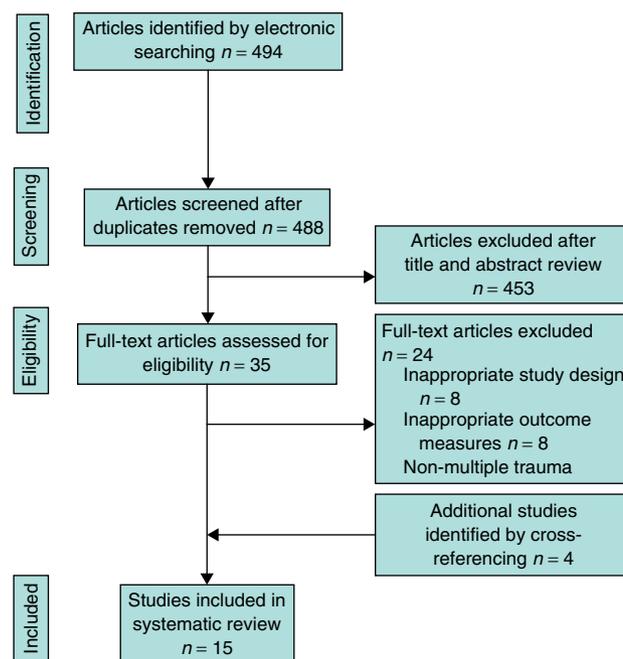
All detailed information from the included studies was tabulated. Meta-analysis was not performed owing to significant heterogeneity between studies in terms of intervention and outcomes measured.

### Results

The study selection process is summarized in *Fig. 1*. The search retrieved 494 published articles; 35 articles met the abstract inclusion criteria and went on to full-text review. Four articles that met the abstract inclusion criteria were identified from the bibliographies of relevant articles. Of these, 15 studies fulfilled the inclusion criteria for this review.

### Characteristics of included studies

No RCTs/CCTs that described rehabilitation interventions for patients with multiple injuries were found. All 15 included trials were observational studies, involving 2386 participants (*Tables 1 and 2*)<sup>17-31</sup>. The included studies were conducted in different continents: five in the USA; five in Europe (one each in the Netherlands, Sweden, Norway, Greece and the UK); three in Australia; and one each in New Zealand and Israel.



**Fig. 1** PRISMA diagram showing the selection of articles for review

**Table 1** Studies describing rehabilitation outcomes after multiple trauma

Reference	Design	Study objective	Outcome measures	Main findings
Holtslag <i>et al.</i> <sup>48</sup>	Prospective cohort study ( <i>n</i> = 335)	Long-term consequences of multiple trauma	GOS, EQ-5D™, HISC	Injury location, educational level and co-morbidity were independent predictors of long-term functional consequences after major trauma. Age > 55 years had higher prevalence of functional limitation
Sayer <i>et al.</i> <sup>49</sup>	Retrospective cohort study ( <i>n</i> = 188)	Outcomes of inpatient rehabilitation for blast and other injuries	FIM, LOS	Predictive values for cognitive outcome included early acute rehabilitation, higher education and presence of psychiatric symptoms. Motor recovery was significantly associated with motor independence on admission, early acute rehabilitation and psychiatric symptoms
Schwartz <i>et al.</i> <sup>50</sup>	Retrospective cohort study ( <i>n</i> = 72)	Comparison of outcomes of multiple injuries between victims of terror and non-terror victims	LOS, FIM, BSI, return to work, psychological outcome	Victims of terror had longer LOS in rehabilitation than non-terror group, and regained most ADL functions similar to the non-terror group. Despite higher rate of PTSD, terror victims succeeded in returning to occupation at a similar rate
Siddharthan <i>et al.</i> <sup>51</sup>	Prospective cohort study ( <i>n</i> = 116)	Effect of rehabilitation on improvement in function and cognitive abilities in patients with multiple trauma	FIM and healthcare costs	Intensive rehabilitation therapy increased functional ability, especially in self-care domains. Inpatient costs exceeded \$4 million in 3 years, with median cost per person of \$25 000
Soberg <i>et al.</i> <sup>52</sup>	Prospective cohort study ( <i>n</i> = 107)	Assess functioning and QoL after severe injuries	SF-36®, WHODAS II, COG	High disease burden due to reduced physical, social and emotional role functioning. Improvement noted in the SF-36® domains (except mental health). No significant change in WHODAS II scores for disease burden. Injury severity, preinjury profession, social functioning and physical functioning showed significant predictive value from baseline to follow-up
Dimopoulou <i>et al.</i> <sup>53</sup>	Prospective cohort study ( <i>n</i> = 87)	Assess HRQoL in multiple trauma survivors 1 year after ICU discharge	NHP, GOS, RDS	Majority exhibited considerable levels of disability and impairment in HRQoL, somatic subdimensions and emotional functioning. High injury severity scores and severe head trauma were independent predictors of poor HRQoL and disability
Storch and Kruszynski <sup>54</sup>	Case series ( <i>n</i> = 5)	Demonstrate effectiveness of a physical rehabilitation programme to improve functional performance following traumatic injury and critical care stay	Long-term functional outcome, QoL, fatigue, return to work	Physiotherapy was effective in restoration of ADLs, but patients were often unequipped to resume their pretrauma level of activity or functional capacity, including return to work or school

GOS, Glasgow Outcome Scale; EQ-5D™ (EuroQol Group, Rotterdam, The Netherlands); HISC, Head Injury Symptom Checklist; FIM, Functional Independence Measure; LOS, length of stay; BSI, Brief Symptoms Inventory; ADL, activities of daily living; PTSD, post-traumatic stress disorder; QoL, quality of life; SF-36®, Short Form 36 (QualityMetric, Lincoln, Rhode Island, USA); WHODAS, World Health Organization Disability Assessment Schedule; COG, Cognitive Function Scale; HRQoL, health-related quality of life; ICU, intensive care unit; NHP, Nottingham Health Profile; RDS, Rosser Disability Scale.

No study in the review mentioned the type of multidisciplinary care, intensity or frequency of therapy/modality. Owing to the lack of data, subgroup analysis based on the timing, frequency and setting of the intervention or severity of multiple trauma was not possible. None of the studies provided direct evidence that organized multidisciplinary

care achieved better outcomes than the absence of such services in these patients. There was lack of information regarding the 'optimal dose' or content of multidisciplinary programmes (for example modalities, duration and intensity of therapy). Outcome measures varied amongst studies (from functional ability, to participation and QoL),

**Table 2** Studies addressing trauma systems, processes or pathways for effective rehabilitation outcomes

Reference	Design	Study objective	Outcome measures	Main findings
Sesperez <i>et al.</i> <sup>55</sup>	Prospective cohort study ( <i>n</i> = 235)	Evaluate effectiveness of clinical pathways for TBI, other trauma and fractures	Compliance and impact of the clinical pathway and/or protocols	Significant improvement in clinical care and compliance reported with pathway elements. Trend towards a reduction in mean hospital LOS. Perceived role of family during the rehabilitation process highlighted
Friedemann-Sánchez <i>et al.</i> <sup>56</sup>	Qualitative study ( <i>n</i> = 56)	Describe rehabilitation services for war-related polytrauma victims and impact on service providers and families	Patient and family involvement, impact on service providers	Families intensely involved in rehabilitation with high expectations. Need for age-appropriate activities in rehabilitation to encourage patient engagement
Zatzick <i>et al.</i> <sup>57</sup>	Prospective cohort study ( <i>n</i> = 97)	Assess patient concerns following traumatic injuries from motor vehicle accidents	SF-12 <sup>®</sup> , PTSD checklist	Most patients expressed physical, psychological, work and financial concerns; few expressed social, legal and medical concerns. Mean number of concerns expressed per patient decreased gradually over time and resembled the PTSD trajectories for functional limitations
Cameron <i>et al.</i> <sup>58</sup>	Prospective cohort study ( <i>n</i> = 117 trauma centres)	Determine effectiveness of statewide system of trauma care resulting in improved survival for patients with major trauma	Mortality rate	Introduction of a statewide trauma system was associated with a significant reduction in risk-adjusted mortality
Derrett <i>et al.</i> <sup>59</sup>	Prospective cohort study ( <i>n</i> = 168)	Collect pre- and post-injury data to identify predictors of disability in injury survivors	WHODAS II, EQ-5D <sup>™</sup> , patient satisfaction	Participants reported a range of anatomical regions injured and injury types, including multiple trauma following vehicle crashes, burns, blood poisoning, sprains and strains
Harris <i>et al.</i> <sup>60</sup>	Prospective cohort study ( <i>n</i> = 355)	Explore possible predictors of general health after major trauma	SF-36 <sup>®</sup> , General Health Survey	Processes involved with claiming compensation after major trauma may contribute to poor patient outcomes. Better physical health significantly associated with increasing time since injury and lower Injury Severity Score
Gabbe <i>et al.</i> <sup>61</sup>	Prospective cohort study ( <i>n</i> = 243)	Establish the use of healthcare services following major trauma	Healthcare service usage, GOS-E	69% reported continued use of healthcare services. Non-compensable patients were significantly more likely to have ceased healthcare service use than compensable patients
Sluys <i>et al.</i> <sup>62</sup>	Prospective cohort study ( <i>n</i> = 205)	Determine QoL after injury and identify factors potentially associated with outcome	SF-36 <sup>®</sup>	68% reported physical and 41% psychological disabilities, and lower SF-36 <sup>®</sup> scores compared with matched population. Poor patient outcome associated with longer LOS, surgery, complications, age, recurrent injury and inadequate information

TBI, traumatic brain injury; LOS, length of stay; SF-12<sup>®</sup>/36<sup>®</sup>, Short Form 12/36 (QualityMetric, Lincoln, Rhode Island, USA); PTSD, post-traumatic stress disorder; WHODAS, World Health Organization Disability Assessment Schedule; EQ-5D<sup>™</sup> (EuroQol Group, Rotterdam, The Netherlands); GOS-E, Glasgow Outcome Scale – Extended; QoL, quality of life.

were insensitive and unable to detect clinically meaningful change over time. No study identified neuropsychological sequelae (for example mood, affect and work-related problems), or long-term issues of ‘ageing with a disability’, participatory limitation or data on cost-effectiveness of rehabilitative care in this population. Quantitative analysis was therefore not possible owing the clinical heterogeneity. The evidence was collated using the GRADE approach, as

recommended by the Cochrane Library<sup>16,32</sup> for quality of evidence.

The low-level evidence from observational studies suggests that, although multiple trauma survivors exhibit considerable levels of functional and cognitive disability, their functional ability and QoL improved following rehabilitation. Physiotherapy was effective in restoring daily life activities, although patients were often unequipped

to resume their pretrauma level of activity or functional capacity (including work or school). Injury location, educational level, age and co-morbidity were identified as independent predictors of long-term functional consequences after major trauma. Functional (motor) recovery was significantly associated with motor independence on admission, early acute rehabilitation and psychiatric symptoms. Although patients with lower functional scores showed the greatest improvement, they continued to be significantly impaired. Access to early acute rehabilitation and level of education contributed to a shorter hospital stay. Trauma care models such as care pathways/protocols were effective in improving care, with favourable patient outcomes. These studies also highlighted the impact of trauma on caregivers, and their perceived role during the rehabilitation process.

## Discussion

This review has highlighted the lack of high-quality studies for effective multidisciplinary rehabilitation in survivors of multiple trauma in terms of: types of rehabilitation setting, components, modalities and duration of therapy, lack of effective care pathways and long-term functional outcomes (including societal reintegration). However, it adds to the existing evidence base in a limited way by providing low-quality evidence from observational studies to support multidisciplinary intervention in this population.

The gaps in the evidence-based rehabilitation practice for multiple trauma survivors identified in this review are similar to issues in rehabilitation research outlined previously for persons with complex chronic neurological conditions<sup>33–35</sup>. These include the lack of robust trials in rehabilitation settings and methodological challenges for research; discrepancy in clinical agreement and practice amongst treating clinicians; lack of incorporation of the perspective of the person with multiple trauma injuries (and their carers); and difficulties with outcome measurement in this population.

Although RCTs are appropriate for studying the effects of an intervention and considered the 'gold standard' for high-level evidence, they are much less suited to studying 'complex' interventions such as rehabilitation<sup>34–36</sup>. The many challenges in rehabilitation for traditional research designs include: heterogeneous interdependent components; different patient populations and contexts; and treatments that are multifaceted, multilayered and involve organizational restructure and individual intervention<sup>33,34,36</sup>. An alternative methodology is the use of 'clinical practice studies' that acquire prospective and retrospective observational data without

disrupting the natural milieu of treatment<sup>37</sup>. This routine data collection provides additional information about the nature of services provided, the outcomes of rehabilitative care, and implications for clinical practice. Further, it can provide answers to what models of care work in which trauma patient populations, the intensity of rehabilitation required, and assessment of care management processes<sup>37,38</sup>. This approach has been used in other complex conditions<sup>39</sup> to quantify intensity of rehabilitation in inpatient rehabilitation programmes, and to determine patient complexity and need for therapy. More research in multiple trauma survivors is needed to build the evidence base in rehabilitation.

A major gap in rehabilitation research is the absence of an internationally agreed framework for the assessment of disability and function. The WHO ICF framework may provide a solution to this. The ICF categories provide information for clinicians about domains considered important by patients, and can be incorporated into their care programmes. These categories provide a common language for effective communication and agreement amongst the treating clinicians. The ICF framework has been applied successfully to outcomes from various neurological diseases<sup>37,38,40</sup>. A similar exercise has yet to be undertaken in patients with multiple trauma to facilitate communication and clinical care between treating clinicians for improved patient outcomes.

Analysis, comparison and agreement on clinical outcomes in trauma rehabilitation programmes are difficult, owing to heterogeneity in the types of programme and use of outcome measures. Despite the widespread usage of acute trauma registries, those that collate data for rehabilitation outcomes are scarce. A comprehensive report used a National Rehabilitation Dataset to review outcomes of inpatient rehabilitation for persons after various conditions, including major trauma (more than 45 000 episodes of care), from 162 accredited rehabilitation facilities across Australia<sup>41</sup>. The results showed a reduction in disability, hospital length of stay and increased discharge of these persons back to the community following inpatient rehabilitation programmes. Such analyses assist in reviewing rehabilitation outcomes nationally and internationally, highlighting areas requiring improved data collection and identifying future clinical needs for planning health service provision. A collaborative integrated practice model for multiple trauma care is needed (acute care and rehabilitation) to address issues of participatory restriction, especially those relating to psychological issues, work, family and social reintegration. This involves education and support for survivors, and for the treating multidisciplinary teams.

Although significant improvements in the coordination and organization of trauma care and services have reduced patient mortality<sup>42</sup>, this has not extended to include rehabilitation services. Most literature on rehabilitation care in trauma survivors exists in 'silos' for isolated conditions such as brain injury, fractures and burns. Although WHO recommends implementation and access to rehabilitation services in developed and developing countries<sup>43</sup>, there are no national or internationally coordinated expanded trauma rehabilitation guidelines to date.

At the global level, injury-related death rates in low- and middle-income countries are higher today than in high-income countries<sup>44</sup>. Despite the high burden of death and disability from injury worldwide, policy responses have been disproportionately low. Trauma-related research lags by 30 per cent behind cancer or heart disease research in the USA, and is much worse in low-middle-income countries<sup>45</sup>. This is due to a population and government belief that injury is different to disease, instead attributing it to carelessness or 'bad luck', and believing that little can be done to prevent this. The death and disability rates from injury can be lowered by addressing the spectrum of injury control as outlined by Mock and colleagues<sup>46</sup>; this includes essentials such as surveillance, prevention and treatment, including rehabilitation care.

There is a need for the ongoing collection of data regarding the extent and characteristics of injury and targeted interventions, and assessment of their success or failure in rehabilitation settings. Most high-income countries have well developed acute surveillance systems for injury, for example the Fatality Analysis Reporting System for automotive death in the USA<sup>47</sup>, and various national trauma registries (Australia, UK, Europe). However, these systems are not so well developed in rehabilitation care. In the USA and Australia, national data sets for outcomes of rehabilitation care exist<sup>48</sup> and are a valuable source for studying outcomes in rehabilitation for trauma and injuries. The UK is currently developing a similar system to that in Australia (L. Turner-Stokes, King's College London, personal communication). The Australian Rehabilitation Outcomes Centre (AROC) data set<sup>41</sup> currently has 170 accredited Australian rehabilitation facilities that submit rehabilitation data to the national data set (including ambulatory data). However, ongoing analysis is needed to improve the quality of data submitted for improved understanding of rehabilitation outcomes. Few low-middle-income countries have surveillance systems specific for injury and/or rehabilitation, and less than 10 per cent of injury-related events or deaths are recorded<sup>46</sup>. One example is the South African National

Non-natural Mortality Surveillance System, which collates data from mortuaries<sup>49</sup>. Data from countries such as Burma, Pakistan and others collate data from governmental and non-governmental sources (such as police reports and vital statistics), and have issues relating to lack of public access to data, under-reporting and questionable data. Although WHO has published guidelines for collecting and processing injury data in acute care<sup>43</sup>, there are currently no such guidelines for rehabilitation. As discussed, the ICF supporting info, ref. 3 can develop data item lists or 'core sets' that need to be addressed in multidisciplinary care settings, and work is in progress to develop valid outcome measurement tools using ICF item banking and scale development techniques<sup>50</sup>.

Globally, the enactment of organized trauma systems and advances in acute care have reduced trauma-related mortality and morbidity rates; these, however, have been successful in high-income countries, but less so in low-middle-income countries. Trauma outcomes from different countries vary, based on economic level. For example, the mortality rate among patients with an ISS of 9 or above increased from 35 per cent in high-income countries (for example, the USA), to 55–63 per cent in low-middle-income countries (for example, Mexico and Africa)<sup>46</sup>. Persons with salvageable injuries (ISS 15–24) in low-middle-income countries have an increased mortality rate; this can be improved upon considerably by means of organized rehabilitation pathways and processes<sup>46</sup>.

The WHO International Guidelines for Essential Trauma Care<sup>43</sup> could be expanded to incorporate rehabilitation intervention. The WHO guidelines utilize the international public health concepts, low-cost and high-yield services, ensuring care to the majority of people in a population. Trauma systems development in rehabilitation, for example, should include minimal training for medical and nursing staff, documentation of care processes, and provision of equipment such as gait aids. In addition, the systems development in high-income countries should be blended within the international public health concepts to establish and promote a core set of essential trauma services and rehabilitation that, if applied widely, would decrease injury-related deaths and disabilities worldwide<sup>51</sup>.

Rehabilitation services development guidelines are needed urgently and should include items such as human resources, skilled and trained staff, and adequate resources (equipment, supplies), made available in institutions of varying levels worldwide. These may range from small rural clinics staffed by health workers, to rural hospitals staffed by general medical staff, to specialist facilities with organized rehabilitation services. However, access

to specialized brain, spinal or burn rehabilitation units for injured persons is not universally affordable.

Finally, rehabilitation guidelines should provide governments and health agencies with resource recommendations such as training programmes, performance improvement strategies, organization of rehabilitation services, site inspections and accreditation systems, and political interactions among stakeholders<sup>46</sup>. As WHO dedicated this decade to reducing 'road traffic trauma', there is now opportunity to prioritize trauma rehabilitation, disability management and social reintegration of trauma survivors.

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### Supporting information

Additional supporting information may be found in the online version of this article:

**Table S1** Current evidence for various rehabilitation interventions in trauma categorized according to study design using evidence defined by the National Health and Medical Research Council programme for intervention studies (Word document)

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