

Spinal Immobilization in Disasters: A Systematic Review

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Abbreviations:

EBG: evidence-based guidelines
ILCOR: International Liaison Committee on Resuscitation
PICO: Patient, Intervention, Control, Outcome
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RRE: resource-rich environment
RSE: resource-scarce environment
SI: spinal immobilization
WADEM: World Association for Disaster and Emergency Medicine

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Abstract

In response to the International Liaison Committee on Resuscitation (ILCOR; Niel, Belgium) release of an updated recommendation related to out-of-hospital spinal immobilization (SI) practice in 2015, a systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist of English-language studies published from January 2000 through July 2019 on the use of SI in resource-scarce environments (RSEs). Studies meeting the following criteria were included in the analysis: peer-reviewed statistical studies or reports detailing management of potential traumatic spinal injury in RSE, civilian, and military environments; as well as consensus clinical guidelines, academic center, or professional association protocols or policy statements detailing management of potential traumatic spinal injury in RSE, civilian, and military environments; statistical analysis; and subsequent management of spinal injuries after mass-casualty incidents, in complex humanitarian events or conflict zones, low-to middle-income countries, or prolonged transport times published by government and non-government organizations. Studies excluded from consideration were those not related to a patient with a potential traumatic spinal injury after a mass-casualty incident, in complex humanitarian event or conflict zones, in low-to middle-income countries, or with prolonged transport times.

There were one thousand twenty-nine (1029) studies initially identified. After removal of duplicates, nine hundred-nineteen (919) were screened with eight hundred sixty-three (863) excluded. The remaining fifty-six (56) received further review with fourteen (14) selected studies achieving inclusion. The reviewed articles comprised six (6) types of studies and represented research from institutions in seven (7) different countries (Israel, United States, Haiti, Wales, Pakistan, China, and Iran). Thirteen (13) references were case reports/narrative reviews, retrospective observational studies, narrative literature reviews, scoping reviews, and one systematic review. The majority of literature describing spinal cord injury was predominantly associated with earthquakes and blast-related disasters. There were no SI evidence-based clinical guidelines (EBG) in RSE. Information was obtained that could be used to formulate statements in a modified Delphi study to present to experts to obtain consensus SI EBG in RSE.

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Introduction

A roundtable was hosted by The World Association for Disaster and Emergency Medicine (WADEM; Madison, Wisconsin USA) World Congress on Disaster and Emergency Medicine in Toronto 2017 to explore prehospital spinal immobilization (SI) best practices. The panel objectives were to:

- Identify and review emerging evidence and changes in prehospital SI practice; and
- Consider implementation of a WADEM member working party to develop guidance and inform best practice.

Prior to the World Congress on Disaster and Emergency Medicine, the International Liaison Committee on Resuscitation (ILCOR; Niel, Belgium) released an updated recommendation related to out-of-hospital spinal immobilization (SI) practice: “We suggest against the use of cervical collars by first aid providers (weak recommendation, very-low-quality evidence).”¹

P	Injured patient of any age
I	Spinal immobilization
C	No spinal immobilization
O	No iatrogenic or secondary spinal injury No worsening of spinal injury No avoidable complication from inappropriate spinal immobilization

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Table 1. PICO Search Strategy

Abbreviation: PICO, Patient, Intervention, Control, Outcome.

The roundtable participants queried the practice of prehospital SI in resource-scarce environments (RSEs), specifically after a mass-casualty incident, in a complex humanitarian event or conflict zone, in low-to-middle income countries, or with a prolonged transport time; expressed confusion as to which prehospital providers were referred to in that ILCOR statement; and identified challenges in maintaining appropriate application of SI in RSE. A specific call was requested as an output of the roundtable for WADEM to provide leadership and guidance in this area of practice. An application was endorsed by the then elected WADEM Board of Directors (2017–2019) for the development of an organizational position paper on prehospital SI. This systematic review was developed to inform and support a subsequent modified Delphi study to develop prehospital guidelines for SI in RSE.

Systematic Review Protocol

Spinal immobilization in the context of RSE: a systematic review was conducted.

Systematic Review Objective

The objective of this systematic review is to determine if SI evidence-based guidelines (EBGs) in RSE have been published.

Systematic Review Question

What is appropriate SI in RSE?

Methodology

A systematic review of SI published research literature in RSE was conducted. Systematic review methodology is of value where the subject material is developing and diverse in knowledge and publication. Disaster management practice is of its own volition multidisciplinary; as a consequence, various operational and academic disciplines contribute to the knowledge and evidence base in a variety of forums and databases. This breadth and range of literature is well-suited to systematic review methodology. In particular, there is great diversity of the disaster peer-reviewed literature, and more information can be found in the “grey literature” and in humanitarian practice than in peer-reviewed literature. This is evidenced by a study conducted by Smith, et al in 2009, whom identified nearly 2,000 peer-reviewed, event-specific publications that have been published in seven hundred eighty-nine (789) journals.²

Literature Search Criteria

A research question was developed using the Patient, Intervention, Control, Outcome (PICO) standard to frame the search strategy (Table 1).

Literature Search Methods

The search strategy included only terms relating to or describing the intervention (Table 2). The review included English-language papers published from January 2000 through July 2019 in the

PubMed (National Center for Biotechnology Information, National Institutes of Health; Bethesda, Maryland USA); Medline (US National Library of Medicine, National Institutes of Health; Bethesda, Maryland USA); and Google Scholar (Google Inc.; Mountain View, California USA) databases. Finally, an ancestry search was also performed to identify additional papers on the reference section of the articles.

A review of the “grey literature” in Google Scholar was conducted using the same search terms (Table 2). This literature review was informed by a consideration of policy and non-peer-review professional journals or publications and non-medical media.

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Figure 1).³

Inclusion Criteria—All peer-reviewed statistical studies/reports detailing management of potential traumatic spinal injury in RSE, civilian, and military environments; as well as consensus guidelines, protocols, or other policy statements; statistical analysis; and subsequent management of injuries after sudden onset disasters, natural or man-made, in complex humanitarian events or conflict zones, low-to-middle-income countries, or prolonged transport times published by government and non-government organizations were included.

Exclusion Criteria—Non-English speaking literature, abstracts, citations, thesis, unverified or unsubstantiated press or news media reports, articles that are not related to a patient with a potential traumatic spinal injury in a sudden onset disaster, mass-casualty incident, or trauma after sudden onset disasters, natural or man-made, in complex humanitarian events or conflict zones, in low-to-middle-income countries, or prolonged transport times were excluded.

A secondary hand search of bibliographies was conducted to identify further outputs.

Quality Assessment

Two review authors independently assessed all included studies for risk of bias; any disagreement was resolved by discussion. The quality of the evidence was classified into four categories according to the Grading of Recommendations Assessment, Development, and Evaluation approach.⁴

Key data extracted into an Excel spreadsheet (Microsoft Corp.; Redmond, Washington USA) included: year; sample size; gender, variables assessed; study design; assessment schedule and follow-up period; analysis used; main findings and conclusions; and limitations.

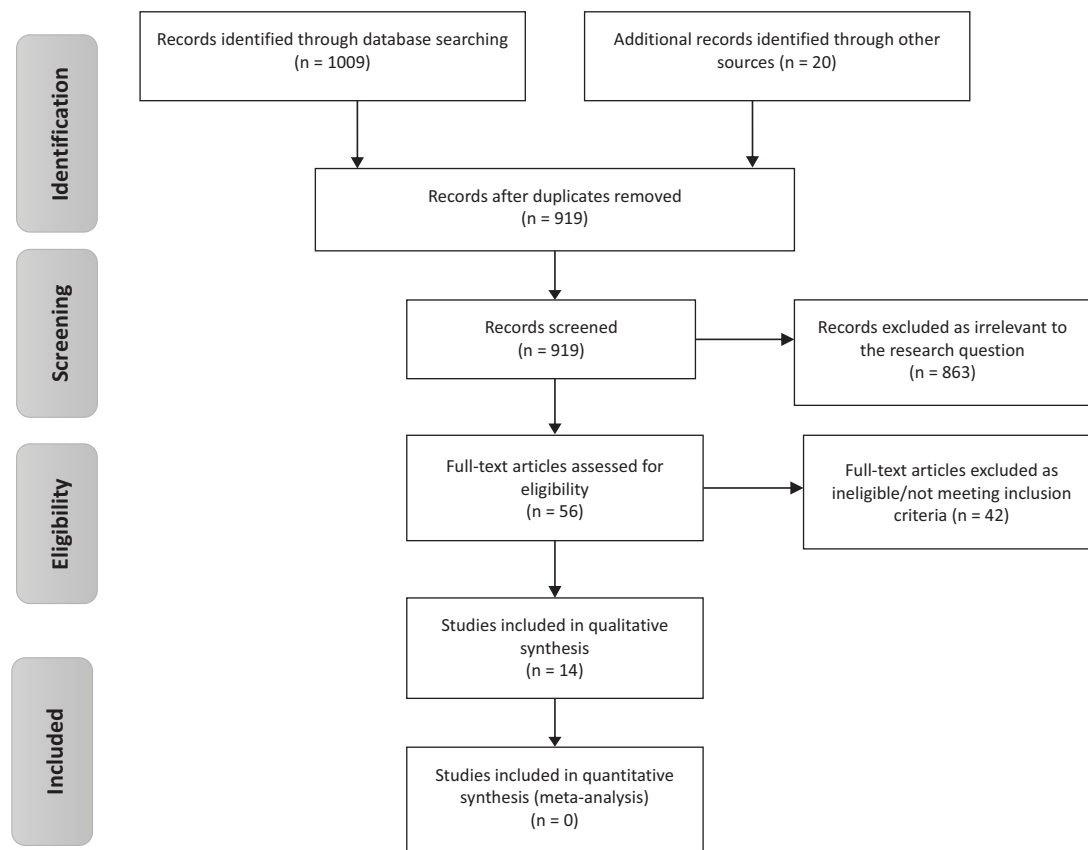
Results

The search strategy yielded a total of one thousand twenty-nine (1029) references. After exclusion of duplicates, nine hundred nineteen (919) titles were identified for further screening. After applying exclusion criteria, eight hundred sixty-three (863) articles were removed. Fifty-six (56) full-text articles were assessed for eligibility, forty-two (42) of these papers were excluded either due to lack of epidemiological data on prehospital spinal cord injury or because they cited earlier publications. A total of fourteen (14) references underwent evaluation (Table 3). The reviewed articles comprised six (6) types of studies and represented research from institutions in seven (7) different countries (Israel, United States, Haiti, Wales, Pakistan, China, and Iran). Thirteen (13)

Sources	Medline/PubMed, CINAHL Plus, Google Scholar
Search Terms	Immobilization Spinal Cord Injury OR Spinal Cord Injuries OR Spinal Injury OR Spinal Injuries OR Spinal Trauma Emergency Medical Services OR Prehospital Emergency Care OR Wilderness Medicine Mass Casualty Incidents OR Terrorism OR Earthquakes OR Disasters OR Natural Disasters Accidents, Traffic Accidental Falls Wounds, Non-Penetrating OR Wounds, Penetrating Rural* OR Outback Resource Scarce
Limits	English Language

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Table 2. Search Terms



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Figure 1. Literature Search Flow Diagram (PRISMA).

Abbreviation: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

references were case reports/narrative reviews, policy statements, retrospective observational studies, narrative literature reviews, and one scoping review.

This systematic review identified a lack of definitive evidence on the utility or effect of spinal motion restriction or immobilization on patient outcomes in disasters. The majority of literature identified in this systematic review described spinal cord injury predominantly associated with earthquakes and blast-related events. The clinical benefit of spinal restriction or immobilization in disasters and across disaster types is unknown and requires further research and evaluation to enable recommendations for SI in

RSEs after a mass-casualty incident, in low-middle income countries, complex humanitarian events, conflict zones, and with prolonged transport times.

Discussion

First responders in RSE may not have commercially available products at their disposal to utilize when treating a trauma patient with potential spinal injury, or have not had robust training through accredited programs in the use of such equipment to facilitate safe and effective practice. Application of evidence-based prehospital guidelines from resource-rich environments (RREs) to overcome

the challenges in the RSE will enable first responders to achieve maximal care. Current EBGs assume multiple levels of commercially available products and well-established training programs to treat the injured in RRE that are not applicable in RSE. Evidence limiting SI in RRE has been slow to be applied in these environments, despite wide promulgation of guidelines and education, due to inappropriate medico-legal fear and lack of an integrated approach amongst prehospital first responders and receiving hospitals. In RSE these factors have been proven to be even more difficult to overcome due to old habits and limited education. Under- or over-treatment of potential spinal injuries can lead to: worse clinical outcomes; avoidable complications related to inappropriate application of SI; and avoidable iatrogenic or secondary spinal injuries. Thus, EBGs will enable first responders in RSE to achieve maximal protection from further injury while avoiding unnecessary SI-related complications or consumption of precious resources.

Prehospital SI is recommended in the World Health Organization's (WHO; Geneva, Switzerland) publication *Coping with Natural Disasters: The Role of Local Health Personnel and the Community. Working Guide*.⁵ A guideline developed by the Wilderness Medicine Society (WMS; Salt Lake City, Utah USA) based on expert panel review currently advocates for the use of SI in austere environments, but notes the lack of evidence supporting this recommendation.⁶

A retrospective review of sixty-four (64) patients requiring mountain rescue with unstable spinal injuries in Snowdonia (Wales, United Kingdom) found that 60% of casualties were not immobilized at-scene; of the cohort not immobilized, no neurological deterioration or exacerbation of spinal cord injury occurred.⁷ A retrospective cohort study of two thousand two hundred sixty-seven (2267) blast victims conducted by Klein, et al found that 0.083% suffered cervical spine injuries and 0.088% had unstable cervical spine fractures, with all but one presenting with irreversible neurological deficit. The authors concluded that scene application of cervical spine collars provided no benefit and risked obscuring penetrating neck injuries.⁸ A narrative review of spinal cord injury following blast in Pakistan by Arsh, et al noted that penetrating injury was the predominate cause of spinal cord injury resulting in neurological deficit.⁹ Irrespective of these findings, published policies of tactical emergency care recommend immobilization following blast without penetrating injury.¹⁰

Narrative reviews examining acute care of spinal cord injury following earthquake recommend immobilization.¹¹⁻¹³ A retrospective review of field first-aid reports from the 2008 Wenchuan Earthquake by Fan, et al reported the use of doors as stretchers for carrying of patients at-scene suffering presumed spinal cord injury and the immobilization of patient head using tape.¹⁴ This practice was also noted in a case report of the response to the Haitian earthquake of 2010.¹⁵ A narrative review of the 2005 Pakistan earthquake reported adverse neurological outcomes following poor prehospital handling of survivors suffering spinal cord injury,¹⁶ and a scoping review by Cartwright, et al reported pressure injuries of survivors suffering spinal cord injury due to inappropriate prehospital care.¹⁵ In a systematic review conducted by Kwan, et al contained in the Cochrane Library Cochrane Evidence Aid: resources for earthquakes (Cochrane; London, United Kingdom) found no evidence from randomized controlled trials on the effectiveness of spinal mobilizations on neurological injury, spinal stability, mortality, and adverse effects in trauma patients.¹⁷ Moreover, the findings of a narrative literature review by Gosney, et al examining spinal cord injury across three international earthquakes noted the lack of evidence base to support spinal cord injury management following earthquake in RSEs.¹⁸

Limitations

This review was limited to qualitative analysis of studies from the literature; due to the scarcity and heterogeneity of reporting, meta-analysis was not possible.

It should be noted that the majority of literature describing spinal cord injury was predominantly associated with earthquakes and blast-related disasters.

Conclusion

There is a lack of high-level evidence on the utility or effect of spinal motion restriction or immobilization on patient outcomes in disasters. There is a need for robust research to determine the clinical benefit of spinal restriction or immobilization in disasters and across disaster types. This systematic review will inform a subsequent Delphi study to develop recommendations and guidance for practice related to prehospital SI in disaster and humanitarian settings.

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Study Authors	Title	Year	Design	Quality of Evidence (GRADE)
Callaway DW, Smith ER, Cain J, Shapiro G, Burnett WT, McKay SD, Mabry R	Tactical Emergency Casualty Care (TECC): Guidelines for The Provision of Prehospital Trauma Care in High Threat Environments	2011	Policy Statement	Low
El Sayed M, Tamim H, Mann NC	Description of procedures performed on patients by Emergency Medical Services during mass-casualty incidents in the United States	2015	Retrospective Review	Low
Gosney JE, Reinhardt JD, von Groote PM, Rathore FA, Melvin JL	Medical rehabilitation of spinal cord injury following earthquakes in rehabilitation resource-scarce settings: implications for disaster research	2013	Narrative Literature Review	Low
Hunt J, Dykes L, Walford T	Unstable spinal fractures in Snowdonia Mountain casualties	2016	Retrospective Review	Low
Klein Y, Arieli I, Sagiv S, Peleg K, Ben-Galim P	Cervical spine injuries in civilian victims of explosions: should cervical collars be used?	2016	Retrospective Review	Low
Lodhi A, Khan SA, Ahmed E, Fatima S, Fatima F, Pasha T, Alvi HF	Prehospital management of spinal injuries in a natural disaster	2011	Retrospective Review	Low
Quinn RH, Williams J, Bennett BL, Stiller G, Islas AA, McCord S	Wilderness Medical Society practice guidelines for spine immobilization in the austere environment: 2014 update	2015	Policy Statement	Low
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	2007	Narrative Review	Low
Priebe MM	Spinal cord injuries as a result of earthquakes: lessons from Iran and Pakistan	2007	Narrative Review	Low
Tanaka H, Oda J, Iwai A, Kuwagata Y, Matsuoka T, Takaoka M, Kishi M, Fumio M, Ishikawa K, Mizushima Y, Nakata Y, Yamamura H, Hiraide A, Shimazu T, Yoshioka T	Morbidity and mortality of hospitalized patients after the 1995 Hanshin-Awaji earthquake	1999	Retrospective Review	Low
Arsh A, Darain H, Ul Haq Z, Ikram AZ, Syed A, Ilyas M	Epidemiology of spinal cord injuries due to bomb blast attacks, managed at paraplegic center Peshawar, Pakistan: a nine years retrospective study	2017	Retrospective Review	Low
Haojun F, Jianqi S, Shike H	Retrospective, analytical study of field first aid following the Wenchuan Earthquake in China	2011	Retrospective Review	Low
Cartwright C, Hall M, Lee A	The changing health priorities of earthquake response and implications for preparedness: a scoping review	2017	Scoping Review	High
Smith, Dyer, Antonangeli, Arredondo, Bedlion, Dalal, Deveny, Joseph, Lauria, Lockhart, Lucien, Marshg, Rogers, Salzarulog, Shah, Toussaint, Wagoner	Disaster triage after the Haitian earthquake	2012	Case Report	Low

Table 3. Studies Included in Qualitative Synthesis

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