The definite risks and questionable benefits of liberal pre-hospital spinal immobilisation

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ABSTRACT

Intro: The routine practice of pre-hospital spinal immobilisation (phSI) for patients with suspected spinal injury has existed for decades. However, the controversy surrounding it resulted in the 2013 publication of a Consensus document by the Faculty of Pre-Hospital Care. The question remains as to whether the quality of evidence in the literature is sufficient to support the Consensus guidelines. This critical review aims to determine the validity of current recommendations by balancing the potential benefits and side effects of phSI.

Method. A review of the literature was carried out by two independent assessors using Medline, PubMed, EMBASE and the Cochrane Library databases. Manual searches of related journals and reference lists were also completed. The selected body of evidence was subsequently appraised using a checklist derived from SIGN and CASP guidelines, as well as Crombie's guide to critical appraisal.

Results. No reliable sources were found proving the benefit for patient immobilisation. In contrast there is strong evidence to show that pre-hospital spinal immobilisation is not benign with recognised complications ranging from discomfort to significant physiological compromise. The published literature supports the Consensus guideline recommendations for safely reducing the impact of these side effects without compromising the patient.

Conclusion The literature supports the Consensus Guidelines but raises the question as to whether they go far enough as there is strong evidence to suggest phSI is an inherently harmful procedure without having any proven benefit. These results demonstrate an urgent need for further studies to determine its treatment effect.

INTRODUCTION

Spinal cord injury is associated with significant morbidity and mortality. There is an immediate risk of death but also severe morbidities such as permanent hemiplegia and tetraplegia. Annually the UK and Ireland have approximately 1000 new cases of spinal cord injury however this is a worldwide problem with all Nations at risk.[1]

Pre-hospital spinal immobilisation

To reduce secondary neurological damage most pre-hospital care systems advocate spinal immobilisation for patients considered at risk. The inherent limitations of identifying this patient group, combined with the assumed benefits of immobilisation and its perceived innocuous nature, has led to a high level of over-treatment.

[2] There is, however, growing concern regarding the effectiveness and potential complications of phSI.

The rationale of phSI, postulated by experts in the mid-1960s, was that after spinal trauma, an unstable vertebral column carries the risk of mechanically severing the spinal cord, leading to catastrophic neurological sequelae.

As there is limited high quality evidence and research in pre-hospital care, the use of phSI continued on the basis of this theory long after its introduction in the mid-1960s. The procedure saw incorporation into the Advanced Trauma and Life Support course (ATLS), as well as local pre-hospital guidelines.[1]

The scrutiny over phSI increased with the shift of focus towards evidence based medicine. This resulted in a number of publications questioning its efficacy. In 1998, Hauswald concluded from biomechanical studies that immobilising the spine is unlikely to prevent further spinal cord damage to the patient.[3] Local oedema and hypoxia were more likely to be contributors to secondary neurological damage. These are time dependent factors, potentially exacerbated by the delays to definitive care involved in immobilising the patient.[3]

Since these studies were released, controversy has continued to grow surrounding the procedure, with greater documentation of adverse effects of its use. [2] This has led to clinicians in the U.K. reflecting upon how phSI should be implicated in modern care.

Consensus Guidelines 2013

Connor et al examined the evidence base concerning phSI on behalf of the Consensus group for the Faculty of Pre-Hospital Care.[3] Recommendations intended to reduce its side effects whilst maintaining the potential benefits included:

- Manual in line stabilisation (MILS) being a suitable alternative to a rigid collar.
- Support for the development and dissemination of an algorithm allowing for selective spinal immobilisation.
- Discouraging the use of immobilisation for penetrating trauma.
- Avoiding the immobilisation of ambulatory patients.
- Encouraging minimal patient handling.
- Discouraging the use of a spinal board for any role other than extrication.
- Advocating the use of a vacuum mattress or scoop stretcher for prolonged transport.

Rationale and Aims

The 2013 Consensus Statement served to highlight that phSI may not be a benign process, with the potential for side effects of varying severity that all patients undergoing the

procedure are exposed to. However, the traditionalised process behind phSI may be saving many patients from death or significant disability. Therefore there is a necessity to examine the evidence base detailing the side effects as well as the potential benefits of phSI.

This critical literature review is designed to appraise the available evidence regarding the potential benefits and side effects of phSI. This is done in order to determine whether the risks of traditional spinal immobilisation outweigh its proposed therapeutic value. In doing so, it also aims to:

- Determine whether the available literature on phSI agrees or disagrees with the 2013 Consensus statement.
- Critically appraise the available literature on phSI to determine whether the evidence base is strong enough to warrant further changes to the traditional protocol.
- Identify any areas where high quality research is still required.

By achieving these aims, recommendations may be made for the improvement of the management of pre-hospital patients with suspected spinal injury.

METHODOLOGY

This critical review aims to determine whether the side effects of pre-hospital spinal immobilisation outweigh the potential benefits. This is intended to determine the validity of the 2013 Consensus statement by scrutinising currently existing evidence.

Search strategy

Online searches were conducted on a number of databases including Ovid Medline, PubMed, Cochrane library, EMBASE, NHS knowledge Network and Google Scholar. Several related journal searches were also conducted of European Journal of trauma, JAMA, Lancet, New England Journal of Medicine, Clinical biomechanics and Spine. The databases and journals were selected based on their propensity for publishing articles related to this study.

MeSH (Medical subject heading) terms were used as search terms for all databases and journals where suitable, and combined with Boolean terminology. Search terms used included “Spinal Immobilisation”, “Immobilisation”, “Spinal injuries”, “Spinal cord injuries”, “Spine”, “Emergency Medical Services” and “Emergency treatment”.

As well as searches using the search functions of the journal websites, the contents lists of all the journal publications used in the online search were also hand searched for relevant titles. However, due to time constraints, journals were only hand searched for three years from the time of this review.

Steps were taken to minimise the risk of publication bias. Unpublished records were sought out for potential inclusion. Reference sections of all selected articles were also scanned for other relevant titles. Professionals in the field of emergency care and spinal immobilisation were also contacted, so that related unpublished literature could be identified.*(See Acknowledgements).* Other potential grey literature sources were searched, including the websites of the London ambulance services, the Scottish and English ambulance services and the BASICS (British Association of immediate care service) website.

Study selection

As part of the screening process all articles which could not be definitely excluded by title were examined by abstract. If necessary, the full text was then examined.

The inclusion and exclusion criteria for the review are included *(See Table 1)*:

- For pragmatic reasons of time and cost, only English articles were considered.
- The significant anatomical differences between humans and animals meant that the latter were not used in this study.
- The difference between pre-hospital and secondary care have a significant effect on decision making, hence the focus on pre-hospital care.[3]
- Only spinal injury through trauma was considered. Spinal injury can occur through medical causes and congenital deformities but their management differs to that of trauma victims.
- Studies on healthy volunteers were included because they can provide useful information on both the biomechanics and ergonomics involved in phSI.
- Study design filters were not used due to the general lack of high quality research in the pre-hospital field.
- It was decided that articles would not be excluded based solely on age, as there is a paucity of evidence in the literature regarding phSI.

Quality assessment

In order to make the critical appraisal process as objective and systematic as possible, a checklist was created based on the SIGN levels of evidence,[4] and a ten-part questionnaire that combined questions from the CASP checklists,[5] and Crombie's "Guide to Critical Appraisal".[6] An example of a completed version is available *(Appendix 4).* The contents of the checklist were agreed upon by all three authors of the study (TAP, PAD, BC). To ensure the best quality of articles were used, only articles assigned a score of 13 or greater were then assessed for individual strengths and weaknesses*.* These results are presented in table format with the full body of data available as online supplementary material *(Appendix 5).*

One reviewer (TAP) conducted the literature search, the hand searches of relevant journals, followed up reference lists and contacted experts in the field in the search for grey literature. Following this, a second reviewer repeated the process independently. The quality assessment was carried out by two independent reviewers (TAP, PAD) and disagreements over study eligibility or score were arbitrated by a senior author (BC), who would review the disputed article himself, and decide the appropriate score.

The database searches were repeated on a fortnightly basis between the beginning of January to the beginning of April of 2015. The last recorded search of the literature for relevant articles was conducted on the 31st of March 2015.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Studies in English	Non English
Human studies	Animal studies
Pre-hospital care	In hospital care
Emergency services	Long term treatment/rehabilitation
Traumatic spinal injury	Non traumatic spinal injury
Appraisal checklist score 13* or above	Appraisal checklist score below 13*

*****This minimum score was selected using the average scores of the first thirty articles appraised in order to ensure the higher quality articles were included in the study.

RESULTS

A flow chart illustrating the process of the literature search is included *(See Figure 1).* In total, 36 articles were included in the review. This consisted of 8 systematic reviews, 2 meta analyses, 1 critical review, 6 case control studies, 2 cohort studies and 17 observational studies. These 36 papers were scored using the constructed checklist and comments were made concerning individual strengths and weaknesses of each study.

The breakdown of the checklist scores are included *(See Table 2).*The articles were subjectively scrutinised by the same two authors for the presence of biases of selection, detection, performance, attrition and reporting *(See Table 3).*

Table 2 Documenting the answers for the appraisal checklist for each of the papers.

Record author, date	SIGN score /10	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	Total score /20
Ahn, Singh et al 2011	10	y	?	?	y	y	n	?	y	y	y	17.5
Anderson et al 2010	8	n	y	y	?	y	?	y	y	?	y	15.5
Oteir et al 2014	10	n	?	?	?	y	y	?	y	y	y	17
Oteir et al 2015	10	y	?	y	y	?	y	?	y	?	?	17.5
Sundstrøm et al 2014	10	y	y	?	?	y	y	?	y	n	y	17.5
Blackham et al Benger 2009	8	n	y	y	?	y	y	?	y	y	y	16
Kwan et al 2007	10	y	y	y	y	?	y	?	?	?	y	18
Kwan et al 2005	10	n	y	y	y	y	y	?	y	?	?	18.5
Abram et al 2010	10	n	?	?	?	y	y	y	y	?	y	17
Ham et al 2014	8	y	y	y	y	?	y	?	?	?	y	16
Stuke 2011	8	y	y	y	?	y	y	y	y	n	y	16.5
Cordell,et al 1993	6	y	y	y	y	?	y	y	n	n	y	13.5
Chan et al, 1993	6	y	y	n	?	n	?	y	y	y	y	13
Berg et al, 2010	6	y	y	n	y	y	?	y	y	?	y	14
Hemmes et al 2014	8	y	y	y	n	?	?	y	y	y	y	16
Mahshidfar 2013	8	y	y	?	n	?	?	n	?	?	?	13
Edlich et al 2011	6	y	y	?	?	y	y	?	?	?	y	13.5

Del Rossi 2010	6	y	y	?	y	y	?	?	?	y	y	14
Krell 2006	6	y	y	?	y	y	y	?	?	y	y	14.5
Johnson et al 1996	6	y	y	?	?	n	y	y	?	y	y	13.5
Hamilton et al 1996	6	y	y	?	n	y	y	n	y	y	y	13.5
Main et al1996	6	y	y	n	?	y	?	y	y	y	y	14
Mobbs 2002	6	y	y	?	?	y	y	y	n	y	?	13.5
Davies et al, 1993	6	y	y	n	?	n	?	y	y	y	y	13
Dodd , 1995	6	y	y	?	?	y	?	n	y	y	?	13
Vallaincourt 2009	6	y	y	y	?	y	y	y	?	y	y	15
Domeier 2005	6	y	y	?	?	?	y	y	?	y	y	14
Stroh et al 2001	6	y	y	?	?	y	y	y	y	y	y	15
Hoffman 2000	6	y	y	y	?	?	y	y	?	y	y	14.5
Belbin 2009	6	y	y	?	?	y	y	y	y	?	?	14
Ben Galim 2010	6	y	y	n	n	y	?	y	y	y	?	13
Hauswald et al 1998	6	y	y	?	?	y	y	y	?	y	?	14
Mazolewski et al, 1994	6	y	y	?	y	y	y	y	n	y	?	14
Ay, Aktas 2011	6	y	y	y	y	?	n	?	y	?	?	13
Bruijns, et al 2013	6	y	y	y	?	y	?	?	y	?	y	14
Del Rossi 2008	6	y	y	n	?	y	y	?	y	y	?	13.5
Hood 2015	10	y	y	?	?	?	y	y	y	y	?	18
Dixon 2014	6	y	?	?	y	y	y	?	?	y	y	14

*Key for table Y = Yes (1 point)
N = No (0 points)
? = Maybe/Not sure (0.5 points)

Table 3 Documenting risk of bias in each of the 36 papers*

Record author, date	Selection bias	Performance bias	Detection bias	Attrition bias	Reporting bias
Ahn, Singh et al 2011	-	+	+	?	-
Anderson et al 2010	?	+	+	?	+
Oteir et al 2014	?	+	+	-	-
Oteir et al 2015	+	+	?	+	-

Sundstrøm 2014	-	+	?	-	?
Blackham, Benger 2009	?	?	-	+	-
Kwan, Bunn, Roberts 2007	+	+	?	-	+
Kwann et al 2005	-	+	+	+	+
Abram et al 2010	-	-	+	+	+
Ham et al 2014	+	+	+	+	+
Stuke 2011	-	?	+	+	+
Cordell, Hollingsworth et al 1993	-	-	-	+	+
Chan, Goldberg, 1993	-	+	-	+	?
Berg, Nyberg et al, 2010	-	+	+	-	-
Hemmes, Brink, 2014	+	-	+	+	?
Mahshidfar 2013	-	-	-	?	?
Edlich, Mason et al 2011	-	?	+	+	?
Del Rossi 2010	+	-	+	+	+
Krell 2006	-	+	-	+	?
Johnson, Hauswald, Stockoff 1996	-	-	-	+	+
Hamilton, Pons 1996	+	?	-	+	-
Main, Lovell 1996	-	+	-	+	+
Mobbs 2002	-	-	+	-	-
Davies et al, 1993	-	-	+	?	?
Dodd, Simon, 1995	-	-	+	?	+
Vallaincourt 2009	-	+	?	?	-
Domeier 2005	-	+	+	?	?
Stroh, Braude 2001	-	+	+	-	-
Hoffman 2000	?	?	+	-	+
Belbin 2009	+	?	+	+	+
Ben Galim 2010	-	+	-	+	+
Hauswald, Ong et al 1998	-	+	+	+	-

Mazolewski, Mannix, 1994	?	+	+	+	+
Ay, Aktas 2011	+	+	-	?	?
Bruijns, Gully, Wallace, 2013	?	+	?	+	?
Del Rossi 2008	-	+	+	+	-
Hood 2015	+	+	?	+	+
Dixon 2014	?	?	+	+	?

*Key for table: + = low risk of bias
- = high risk of bias
? = unknown risk of bias

The two authors that carried out the individual appraisals (TAP, PAD) had no disagreements concerning article inclusion and produced similar scores for article appraisal. In cases where there was disagreement in article score, these varied by no more than a single point.

The scored articles were subsequently tabulated. The information recorded included title, type of study, main outcomes, whether these outcomes support the 2013 Consensus Statement, checklist score out of 20 and a summary of individual article strengths and weaknesses. A summary table of the systematic reviews, meta analysis and critical review are presented here *(Table 4).* Due to its large size, the complete table of results is available as online supplementary material *(Appendix 5)*.

Table 4 Summarising outcomes of the highest scoring articles of 36 included in this study

Study	Type	Outcomes	Support Consensus Guidelines?	Checklist Score /20	Individual strengths/weaknesses
Oteir 2015	Systematic review	Cervical spine immobilisation is controversial in blunt trauma.	Yes	15.5	Used Newcastle-Ottawa scale. Excluded groups with healthy volunteers.
Oteir 2014	Systematic review	Routine use of cervical collar should be phased out, as side effects outweigh benefits.	Yes	17	Use of numerous authors for literature search. Experts in the field contacted. Only documented use of one database.
Ham et al 2014	Systematic review	Immobilisation leading to increased incidence of pressure sores in occiput and sacral areas, contributing to patient morbidity.	Yes	16	Used Research Appraisal Checklist for Nursing as well as PRISMA statement. Only looked at quantitative studies.
Sundstrom 2014	Critical review	Use of phSI should not delay transport to hospital	Yes	17.5	Reference lists searched. Only documents use of one database.
Ahn, Singh 2011	Systematic review	Remove patients from the spinal board as soon as possible. Suitable alternatives to use of cervical collar need to be found.	Yes	15.5	Use of two reviewers and Delphi method of discussion. No journal search found.
Stuke et al 2011	Systematic review	Little evidence supporting the use of phSI. Proper examination of the neck should take priority over immobilisation.	Yes	16.5	Bibliographies cross referenced and multiple authors involved. No inclusion or exclusion criteria found.

Anderson 2010	Meta Analysis	Selective immobilisation protocols NEXUS and CCSR have a high enough sensitivity to be used safely routinely.	Yes	15.5	Each paper was reviewed by three different authors. No journal search found.
Abram 2010	Critical Review	Immobilisation can be contributing to morbidity and mortality and this warrants further investigation.	Yes	17	Short methodology, no details found of searches for unpublished literature or journal searches.
Blackham, Benger 2009	Systematic review	NEXUS and CCSR both approach 100% sensitivity for detecting C-spine fractures.	Yes	16	Could not find explanation for search criteria or evidence of search for unpublished literature.
Kwann, Bunn, Roberts 2007	Systematic review	Immobilisation may lead to airway compromise, contributing to patient morbidity and mortality.	Yes	18	Articles assessed separately on their degree of allocation concealment by multiple authors. No rationale for sensitivity analysis described.
Kwann et al 2005	Systematic review	Adverse effects of phSI including respiratory compromise, skin ischemia, longer hospital stays and increased costs.	Yes	18.5	Quality of allocation concealment was assessed. Heterogeneity of results noted.

Consensus Guidelines

It was noted that the conclusions drawn in the critically appraised articles correlated with the Consensus Guidelines, [3] *(Appendix 10)* regarding:

- Discouraging the use of immobilisation for penetrating trauma.[7]
- Encouraging the use of new immobilisation technologies such as the Scoop stretcher,[8] the Vacuum mattress,[9] and the ResQRoll.[10]
- Discouraging the routine use of cervical collars.[9-10].
- Encouraging selective immobilisation rather than a blanket policy.[11-13]

The articles identified with contrary conclusions to the Consensus guidelines were found to have been of low quality, containing substantial levels of bias, inconsistencies in the methodology and missing data.

Therefore the process of phSI, as endorsed by the 2013 Consensus guidelines, is sufficiently validated in the literature.

Side effects

The side effects of phSI are well documented. The evidence appraised confirmed that phSI can result in:

- Pain and discomfort, ranging from moderate to severe, that may continue over the next 48 hours.[15]
- Tissue ischemia and increasing incidence of pressure ulcers, particularly in unconscious patients.[16]
- Increased respiratory effort, and decreased pulmonary function.[17]
- Increased intracranial pressure.[12]
- Longer hospital stays, increased radiographs and subsequent increase in cost and exposure to hospital acquired infections and radiation.[18]
- Impeded examination of the neck.[7]

- Cervical distraction.[11]
- Delayed transport, increasing time to definitive care.[19]
- Confounding clinical examination and vital sign recordings.[20]

Hauswald,[21] and the authors of three systematic reviews,[18,22,23] conclude that phSI may be contributing to patient morbidity and mortality.

Benefits

In contrast to side effects, no studies confirmed that phSI improved patient outcomes.

Numerous studies looked at occasional incidents where the patient's vertebral fracture was missed until later in their care, and thus they were not immobilised beforehand. Their subsequent clinical outcomes were then evaluated, including morbidity and mortality rates.[24-26]

Platzer showed, via an observational study, that a delayed diagnosis of cervical spine injury correlated with higher rates of morbidity and mortality compared to patients who were diagnosed sooner.[25] Despite this observation, no connection is made between phSI and the prevention of neurological deterioration. It was impossible to conclude from these studies that phSI would necessarily have prevented the negative outcomes seen in these patients.

In the systematic review by Abram et al,[23] the number of immobilisations needed to prevent one patient from suffering permanent neurological damage was calculated using the work of Davis and Platzer.[25,26] The Number Needed to Treat (NNT) from Davis et al was 150, and from Platzer et al was 392.[25,26]

Conversely, Ahn and Singh found that 8% of vertebral column injuries were not immobilised and no clinical consequences resulted.[19] Gerrelts et al found that patients with a delayed diagnosis of cervical spine fracture did not develop permanent neurological deficits.[27]

There were no case-control studies that directly compared the outcomes of patients who were immobilised against those that were not. This was possibly due to the ethical and litigious difficulties in creating such a study

Four systematic reviews have also concluded that there is insufficient evidence to validate the potential benefits of phSI.[7, 18, 22, 23]

Summary of results

Table 5 Comparing the number of studies that documented risks vs benefits of phSI.

Studies showing risks of phSI	Studies showing benefits of phSI	Studies showing both risks and benefits of phSI.
Oteir 2014	Mahshidfar 2013	Ahn, Singh et al 2011
Oteir 2015	Riggins 1977	Anderson et al 2010
Sundstrom 2014	Platzer 2006	Blackham, Benger 2009
Kwann et al 2007	Davies 1993	Dodd 1995
Kwann et al 2005	-	Vallaincourt 2009
Abram 2010	-	Domeier 2005
Ham 2014	-	Stroh 2010
Stuke et al 2011	-	Hoffman 2000
Cordell et al 1993	-	Del Rossi 2008
Chan 1993	-	-

Berg 2010	-	-
Hemmes 2014	-	-
Edlich 2011	-	-
Del Rossi 2010	-	-
Krell 2006	-	-
Johnson 1996	-	-
Hamilton 1996	-	-
Main 1996	-	-
Mobbs 2002	-	-
Davies 1993	-	-
Belbin 2009	-	-
Ben Galim 2010	-	-
Hauswald 1998	-	-
Mazolewski et al 1994	-	-
Ay, Aktas 2014	-	-
Bruijins 2013	-	-
Hood 2015	-	-
Dixon 2014	-	-

Quantifying the risks of immobilisation

Efforts were made to quantify the negative effects of phSI. The frequencies of the major side effects are presented *(Table 6)*.

- A systematic review, by Ham et al, concerning the relationship between collar immobilisation and subsequent pressure ulcers established a significant correlation (6.8% to 38% incidence).[16]
- In a prospective study by Chan and Goldberg, 21 healthy volunteers were placed in backboard immobilisation and observed for half an hour. Within the immediate observation period, 100% of the subjects reported pain, and 55% reported moderate to severe pain.[15]
- The efficiency of the ambulance service as a whole may be affected by phSI. The National Audit office of the UK found the average cost of each ambulance use in 2011 to be between £176 and £251.[29] This cost is increased by the time and resources used by the meticulous process of phSI. The response time of the ambulance service to other patients may also be affected, which is expected to be less than 8 minutes for an unresponsive patient.[29]
- The cervical collar was found in one study to press on the veins of the neck, increasing the intracranial pressure (ICP) by 4.4mmHg. This increases the potential risk of neurological sequelae, particularly if the patient is also suffering from traumatic brain injury.[12]

Table 6 Quantifying the risks of phSI

Risks of phSI	Types of study that demonstrate this risk:	Number of studies that demonstrated this risk out of the 36 articles appraised:	Percentage of studies that demonstrated this risk.
Delays in reaching definitive care:	Systematic review, observational study	4	11.1%
Masking of other pathology:	Systematic review, prospective observational study	5	13.9%
Pressure ulcers:	Systematic review, randomised control trial, observational study, experiment	8	22.2%
Pain and discomfort:	Systematic review, randomised control trial, observational study, experiment, prospective crossover study,	11	30.6%
Airway compromise:	Systematic review, prospective observational	5	13.9%
Raised intracranial pressure:	Systematic review, prospective observational study,	3	8.33%
Cervical vertebrae distraction	Cadaveric study	1	2.78%
Decreased pulmonary function	Cross-over trial	1	2.78%

DISCUSSION

Following a detailed search of the published and grey literature, 36 papers were critically appraised to evaluate phSI. Extensive reliable evidence was found detailing numerous side effects, with no proven benefit. It was also found that the Consensus Guidelines take effective steps towards minimising phSI's potential complications.

Limitations

This critical review focused only on English studies, and as such relevant articles may have been missed. However, given the methodology used to ensure the literature search was comprehensive, the probability of this occurring has been minimised.

The 36 papers that were critically evaluated included a number of systematic reviews on phSI. Some studies appeared in more than one of the systematic reviews. However, the quality of the available evidence was the main subject of this critical review. As a result, the overlap across systematic reviews was such that it did not affect the outcomes of the study.

Areas of weakness in the literature

Oteir describes the "paucity of evidence" connecting phSI to a positive effect on neurological outcomes.[22] In contrast, there is an abundance of reliable literature detailing the harm that phSI can inflict upon trauma victims with suspected spinal injury.

The study by Hauswald showed better neurological outcomes in a catchment area that did not use phSI compared to a region utilising the procedure. This may indicate that the practice has an overall negative effect on patient outcomes.[21] He proposes that local hypoxia and oedema are greater contributors to secondary neurological injury than the risk of mechanical severance. If true, his hypothesis would strongly oppose the current school of thought on phSI. More research is required, however, to reliably validate these claims.[28]

Barriers to change

Historical acceptance, concerns about patient harm, and fears of litigation all provide barriers to the process of phSI. Consequently it will continue to be used by pre-hospital emergency personnel until there is substantial evidence showing it only causes harm with no therapeutic effect.

CONCLUSION

The evidence appraised in this critical review suggests that the side effects of phSI may outweigh the potential benefits. However, a lack of proven benefit for phSI does not definitively establish that there is no benefit to the practice.

Recommendations

Ideally, a prospective, randomised controlled trial is required. This would be comparing patients with suspected spinal injury who undergo phSI with those who do not. However this would be very difficult to carry out, given the medico-legal implications of such a trial as well as the scale required to achieve statistical significance.

Hauswald's theories regarding spinal injury should be investigated with further biomechanical studies to determine their efficacy, as this would have a significant influence on current practice.[28]

Until the benefits of phSI can be reliably proven or disproven, the priority among clinicians is to minimise the negative effects of phSI, and to safely lower the number of patients subjected to it. The Consensus guidelines will achieve this, and their assimilation into U.K. practice is sufficiently warranted in the literature.[3]

Contributorship Statement

All three authors (TAP, PAD, BC) were involved in the planning of this study. TAP and PAD conducted the literature review and critical appraisal. BC arbitrated disagreements over study eligibility or score by reviewing disputed articles himself, and deciding the appropriate score. The study was submitted by TAP.

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