Spinal immobilisation for trauma patients (Review)

Kwan I, Bunn F, Roberts IG

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Spinal immobilisation for trauma patients

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ABSTRACT

Background
Spinal immobilisation involves the use of a number of devices and strategies to stabilise the spinal column after injury and thus prevent spinal cord damage. The practice is widely recommended and widely used in trauma patients with suspected spinal cord injury in the pre-hospital setting.

Objectives
To quantify the effect of different methods of spinal immobilisation (including immobilisation versus no immobilisation) on mortality, neurological disability, spinal stability and adverse effects in trauma patients.

Search methods
We searched the Cochrane Central Register of Controlled Trials (CENTRAL), the Cochrane Injuries Group's specialised register, MEDLINE, EMBASE, CINAHL, PubMed, National Research Register and Zetoc. We checked reference lists of all articles and contacted experts in the field to identify eligible trials. Manufacturers of spinal immobilisation devices were also contacted for information. Searches were last updated in July 2007.

Selection criteria
Randomised controlled trials comparing spinal immobilisation strategies in trauma patients with suspected spinal cord injury. Trials in healthy volunteers were excluded.

Data collection and analysis
We independently applied eligibility criteria to trial reports and extracted data.

Main results
We found no randomised controlled trials of spinal immobilisation strategies in trauma patients.
Authors’ conclusions

We did not find any randomised controlled trials that met the inclusion criteria. The effect of spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients remains uncertain. Because airway obstruction is a major cause of preventable death in trauma patients, and spinal immobilisation, particularly of the cervical spine, can contribute to airway compromise, the possibility that immobilisation may increase mortality and morbidity cannot be excluded. Large prospective studies are needed to validate the decision criteria for spinal immobilisation in trauma patients with high risk of spinal injury. Randomised controlled trials in trauma patients are required to establish the relative effectiveness of alternative strategies for spinal immobilisation.

Plain Language Summary

Spinal immobilisation for trauma patients

Spinal cord damage from injury causes long-term disability and can dramatically affect quality of life. The current practice of immobilising trauma patients before hospitalisation to prevent more damage may not always be necessary, as the likelihood of further damage is small. Means of immobilisation include holding the head in the midline, log rolling the person, the use of backboards and special mattresses, cervical collars, sandbags and straps. These can cause tissue pressure and discomfort, difficulty in swallowing and serious breathing problems.

The review authors could not find any randomised controlled trials of spinal immobilisation strategies in trauma patients. It is feasible to have trials comparing the different spinal immobilisation strategies. From studies of healthy volunteers it has been suggested that patients who are conscious, might reposition themselves to relieve the discomfort caused by immobilisation, which could theoretically worsen any existing spinal injuries.

Background

The incidence of spinal cord injury (SCI) in the USA is estimated to be between 40 and 50 cases per million people per year (SCI Center 1998). Spinal cord injury results in long-term disability, often with profound effects on the quality of life of the affected individuals and their carers. In the USA, the lifetime medical costs resulting from spinal cord injury are estimated at nine billion dollars per year (Miller 1994). Existing data in developing countries are limited. A study from Beijing estimated the incidence of SCI at seven cases per million people per year (Wang 1990). Acute traumatic SCI occurs in about 3% of trauma admissions, and around half of these injuries involved the cervical spine (Burney 1993).

In males under the age of 50, road traffic crashes are the most common cause of SCI (Burney 1993).

In response to the concern that an unstable spine will increase the frequency and severity of neurological injury, a number of approaches have been developed that aim to achieve spinal immobilisation. The two main methods are manual stabilisation and the use of orthotic devices such as backboards and splints, with a combination of adjuncts including cervical collars, sandbags and straps. Pre-hospital spinal immobilisation aims to stabilise the spine by restricting mobility, thus preventing secondary SCI during extraction, resuscitation, transport and evaluation of trauma patients with suspected spinal instability. It is estimated that 5% of trauma patients with cervical spinal injuries have missed or delayed diagnosis (Davis 1993), resulting in preventable mortality and morbidity. Occult cervical spine injuries may be more likely to be missed in obtunded patients with unstable spines, in whom it may be masked by the pain of multi-system injury and altered level of alertness. Spinal immobilisation is now routinely practised in the pre-hospital care of trauma patients and is widely recommended in a range of resuscitation guidelines (Advanced LS 1993, Advanced Paediatric Life Support, Pre-hospital ‘Trauma Life Support’, Advanced Life Support Group 1993, ACS 1997).

Despite the widespread use of spinal immobilisation, the clinical benefits of pre-hospital spinal immobilisation have been questioned. It has been argued that spinal cord damage is done at the time of impact and that subsequent movement is generally not sufficient to cause further damage (Hauswald 1998). Most trauma patients do not have spinal instability and, hence, will not benefit from spinal immobilisation. Nevertheless, largely in response to the fear of litigation, some five million patients in the US receive spinal immobilisation every year (Orledge 1998). However, there may be adverse effects. Observational studies have shown that rigid collars may cause airway difficulties, increased intracra-
nal pressure (Davies 1996), increased risk of aspiration (Butman 1996), restricted respiration (Totten 1999), dysphagia (Houghton 1996) and skin ulceration (Hewitt 1994). Because any benefits of spinal immobilisation may be outweighed by the risks, the value of routine pre-hospital spinal immobilisation remains uncertain.

This systematic review aims to quantify the effect of different spinal immobilisation devices (including immobilisation versus no immobilisation) on their ability to immobilise the spine and on mortality, neurological injury, and adverse effects in trauma patients.

**OBJECTIVES**

- To quantify the effect of spinal immobilisation versus no spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients.
- To quantify the effect of different spinal immobilisation strategies on mortality, neurological injury, spinal stability and adverse effects in trauma patients.

**METHODS**

**Criteria for considering studies for this review**

**Types of studies**
Randomised controlled trials.

**Types of participants**
Trauma patients with suspected spinal cord injury.

**Types of interventions**
All strategies of spinal immobilisation including:
- backboards, mattress splints
- rigid and soft collars
- sandbags, straps or tapes
- collar and backboard combinations
- holding the head in the midline
- log rolling the patient.

**Types of outcome measures**
- Mortality.
- Neurological injury.
- Degree of spinal stability.
- Adverse effects.

**Search methods for identification of studies**

**Electronic searches**
We searched the following electronic databases:
- Cochrane Injuries Group’s specialised register
- Cochrane Central Register of Controlled Trials (CENTRAL)
- MEDLINE
- EMBASE
- CINAHL
- National Research Register
- ZETOC
- http://www.clinicaltrials.gov
- http://www.controlled-trials.com/mrct

These searches were last carried out in July 2007. The full search strategies are presented in the additional tables: Table 1 shows search strategies used previously in May 2003, Appendix 1 shows strategies used for the July 2007 update.

**Searching other resources**
Additionally all references in the background papers were checked and six authors contacted to identify potential published or unpublished data. Eight manufacturers of immobilisation devices were also contacted. There was no language restriction in any of the searches.

**Data collection and analysis**

**Selection of studies**
One author (IK) examined the electronic search results for reports of possibly relevant trials and these reports were then retrieved in full. One author (FB) examined 10% of the electronic search results to check for agreement on eligibility criteria. Two authors (FB, IK) applied the selection criteria independently to the trial reports, resolving disagreements by discussion with a third author (IR).

The following are the proposed methods which will be applicable if trials are found during subsequent updates of the review.

**Data extraction and management**
Two authors will independently extract data and information on the following:
- method of allocation concealment,
- number of randomised patients,
- type of participants,
- type of interventions,
• loss to follow-up,
• length of follow-up.

The authors will not be blind to the study authors or journal when doing this. Results will be compared and any differences resolved by discussion.

Where there is insufficient information in the published report, we will attempt to contact the trial authors for clarification.

Assessment of risk of bias in included studies

Since there is evidence that the quality of allocation concealment particularly affects the results of studies (Schulz 1995), two authors will score this quality on the scale used by Schulz as shown below, assigning C to poorest quality and A to best quality:

• A = trials deemed to have taken adequate measures to conceal allocation (that is, central randomisation; serially numbered, opaque, sealed envelopes; or other description that contained elements convincing of concealment)
• B = trials in which the authors either did not report an allocation concealment approach at all or reported an approach that did not fall into one of the other categories.
• C = trials in which concealment was inadequate (such as alternation or reference to case record numbers or to dates of birth).

If the method used to conceal allocation is not clearly reported, the trial author(s) will be contacted, if possible, for clarification. Differences will be resolved through discussion.

We will assess the skewness of continuous data by checking the mean and standard deviation (if available). If the standard deviation is more than twice the mean for data with a finite end point, the data are likely to be skewed and it is inappropriate to apply parametric tests (Altman 1996). This is because the mean is unlikely to be a good measure of central tendency. If parametric tests cannot be applied, we will tabulate the data.

Assessment of heterogeneity

The groups of trials will be examined for statistical evidence of heterogeneity using a chi-squared test. If there is no obvious heterogeneity on visual inspection or statistical testing, pooled RR and 95% confidence intervals will be calculated using a fixed effects model.

Data synthesis

The following comparisons are proposed:

• spinal versus no spinal immobilisation,
• different strategies of spinal immobilisation.

For dichotomous outcomes, such as death, the relative risk (RR) will be calculated with 95% confidence intervals, such that a RR of more than 1 indicates a higher risk of death in the first group named. The RR will be used as it is more readily applied to the clinical situation.

Sensitivity analysis

The effect of excluding trials judged to have inadequate (scoring C) allocation concealment will be examined in a sensitivity analysis.

RESULTS

Description of studies

See: Characteristics of excluded studies.

No randomised controlled trials comparing the effect of spinal immobilisation strategies on trauma patients were found.

Risk of bias in included studies

Not applicable.

Effects of interventions

Our search strategy identified 4453 potentially eligible reports. However, there were no trials meeting the inclusion criteria. A number of randomised controlled trials were identified comparing different spinal immobilisation strategies in healthy volunteers. The results of randomised controlled trials on healthy volunteers may provide some useful insights into their relative effectiveness in trauma patients. For this reason, although trials of healthy volunteers did not meet our inclusion criteria, we have summarised them in the additional tables (Table 2) of the review.

DISCUSSION

We did not find any randomised controlled trials comparing different strategies of spinal immobilisation in trauma patients. The effect of spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients therefore remains uncertain.

We screened 4453 potentially relevant papers, checked their reference lists and contacted experts in the field. We also contacted manufacturers of immobilisation devices for additional information. While it is possible that we might have missed a randomised controlled trial comparing spinal immobilisation techniques in trauma patients, we believe that, due to our thorough search strategy, this is unlikely.
The current protocol for pre-hospital spinal immobilisation has a strong historical rather than scientific precedent, based on the concern that a patient with an injured spine may deteriorate neurologically without immobilisation. The medical and legal concern of missing a cervical spinal injury has lent strong support for the conservative approach of liberal pre-hospital spinal immobilisation to almost all patients with trauma and possible neck injury, regardless of clinical complaint (Butman 1996). It is also suggested that iatrogenic cord damage could be reduced with better paramedic training and improved immobilisation procedures (Perry 1999).

However, it has been argued that considerable force is required to fracture the spine at the initial impact, and that any subsequent movements of the spine are unlikely to cause further damage to the spinal cord (Hauswald 1998). It has also been suggested that pre-hospital spinal immobilisation has never been shown to affect outcome and that estimates in the literature regarding the incidence of neurological injury due to inadequate immobilisation may have been exaggerated (Hauswald 1998; Hauswald 2000). This calls into question the present routine use of pre-hospital spinal immobilisation.

For some patients, effective spinal immobilisation is prudent and can be vital to prevent the devastating effects of cord damage, yet for many the excessive use of this precaution may not be beneficial or necessary. It is estimated that over 50% of trauma patients with no complaint of neck or back pain were transported with full spinal immobilisation (McHugh 1998). Unwarranted spinal immobilisation can expose patients to the risks of iatrogenic pain, skin ulceration, aspiration and respiratory compromise, which in turn can lead to multiple radiographs, resulting in unnecessary radiation exposure, longer hospital stay and increased costs. The potential risks of aspiration and respiratory compromise are of concern because death from asphyxiation is one of the major causes of preventable death in trauma patients.

A set of highly sensitive clinical criteria has been developed and validated (Hoffman 2000) to identify trauma patients at low risk of spinal injury and rule out their need for radiography. These are trauma patients with absence of: neck pain or tenderness, altered level of consciousness, neurological deficit, evidence of intoxication and painful distracting injury. It has been suggested that a similar decision instrument could be developed for use in the pre-hospital setting, to establish the need to immobilise or not to immobilise (Domeier 1999). This is in addition to the criteria of mechanism of injury as the main determinant for out-of-hospital spinal immobilisation.

There are a lack of data from randomised controlled trials to support the practice of pre-hospital spinal immobilisation in trauma patients. While it may not be possible to conduct randomised controlled trials of spinal immobilisation versus no immobilisation in trauma patients, it may be feasible to consider such trials, comparing the different spinal immobilisation strategies, in outcomes of immobilisation efficacy, respiratory effects, tissue pressure and patient comfort in this target population. Results of randomised controlled trials on healthy volunteers may provide some useful insights into their relative effectiveness in trauma patients. For this reason although trials of healthy volunteers did not meet our inclusion criteria we have summarised them in the additional tables section of the review. For example in healthy volunteers, short-board technique was reported to be more efficient than collars alone in reducing spinal mobility (Cline 1985); vacuum mattress and padded backboards more comfortable than rigid backboards (Hamilton 1996; Hauswald 2000; Johnson 1996; Walton 1995).

From these studies on healthy volunteers, it has been suggested that patients on whom spinal immobilisation has been used, and who are conscious, might reposition themselves to relieve the discomfort caused by ischaemia, which could theoretically worsen any existing spinal injuries. Patients who are unable to move or feel pain due to trauma are at risk of soft tissue injuries (Hauswald 2000).

Due to the absence of randomised controlled trials quantifying the effect of spinal immobilisation in trauma patients, and the possible adverse effects of its application, the value of routine pre-hospital spinal immobilisation remains uncertain.

**Authors' Conclusions**

**Implications for practice**

We found no randomised controlled trial which met our inclusion criteria in this review. The effect of pre-hospital spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients therefore remains uncertain. Because airway obstruction is a major cause of preventable death in trauma patients, and spinal immobilisation (particularly of the cervical spine) can contribute to airway compromise, the possibility that immobilisation may increase mortality and morbidity cannot be excluded.

**Implications for research**

Large prospective studies are needed to validate the decision criteria for spinal immobilisation in trauma patients with high risk of spinal injury. In addition, randomised controlled trials to compare different immobilisation strategies on trauma patients need to be considered in order to establish an evidence base for the practice of pre-hospital spinal immobilisation.

**Acknowledgements**

We thank N Mohan, C Mock, R Norton and M Varghese of the WHO Pre-hospital Trauma Care Steering Committee for their comments and advice on the review.
We also thank R Wentz and K Blackhall for help with the searching, and Dr Jegede for help identifying useful background papers. Finally, thanks to the authors of background papers and manufacturers for supplying additional information.

REFERENCES

References to studies excluded from this review

Black 1998 (published data only)

Chan 1996 (published data only)

Cline 1985 (published data only)

Cordell 1995 (published data only)

Delbridge 1993 (published data only)

Graziano 1987 (published data only)

Hamilton 1996 (published data only)

Hauswald 2000 (published data only)

Jedlicka 1999 (published data only)

Johnson 1996 (published data only)

Lerner 1998 (published data only)

Lunsford 1994 (published data only)

Manix 1995a (published data only)

Manix 1995b (published data only)

Mazolewski 1995 (published data only)

Perry 1999 (published data only)

Totten 1999 (published data only)

Walton 1995 (published data only)

Additional references

ACS 1997

Advanced LS 1993
Altman 1996

Burney 1993

Butman 1996

Davies 1996

Davis 1993

Domeier 1999

Hauswald 1998

Hewitt 1994

Hoffman 2000

Houghton 1996

McHugh 1998

Miller 1994

Orledge 1998

Schulz 1995

SCI Center 1998

Wang 1990

* Indicates the major publication for the study
## CHARACTERISTICS OF STUDIES

Characteristics of excluded studies  *(ordered by study ID)*

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<tr>
<td>Chan 1996</td>
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</tr>
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<td>Cline 1985</td>
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<td>Graziano 1987</td>
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<td>Hamilton 1996</td>
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<tr>
<td>Hauswald 2000</td>
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<td>Jedlicka 1999</td>
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<td>Johnson 1996</td>
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<td>Perry 1999</td>
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<td>Walton 1995</td>
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DATA AND ANALYSES

This review has no analyses.

ADDITIONAL TABLES

Table 1. Previous search strategies May 2003

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<td>2. IMMOBIL*:TI or STABILI*:TI or STABLE:TI or COLLAR*:TI or BACKBOARD:TI or SPLINT*:TI or BOARD*:TI or STRAPPING:TI or STRAPPED:TI</td>
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<td>3. HEADBLOCK:TI or SANDBAG:TI or ORTHOSIS:TI or ORTHOTIC:TI or BRACE*:TI</td>
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<td>6. #1 or #2 or #3 or #4 or #5</td>
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<td>7. immobili* or mobility</td>
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<td>10. collar*</td>
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<td>12. headblock* or sandbag* or (kendrick in ti,ab) or orthosis</td>
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<td>14. brace*</td>
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<td>15. spine board* or splint*</td>
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<tr>
<td>17. log rol*</td>
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<td>18. #16 or #17</td>
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<td>6. neck or whiplash</td>
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<td>7. #1 or #2 or #3 or #4 or #5 or #6</td>
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<tr>
<td>8. immobili* or mobility</td>
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<tr>
<td>9. stabili* or stable or collar*</td>
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Table 1. Previous search strategies May 2003

| 10. backboard* or vacuum splint* or neutral position* or strapping or strapped or straps or spine board* or tapes or taping |
| 11. headblock* or sandbag* or (kendrick in ti,ab) or orthodos* or orthotic* or brace* |
| 12. spine board or splint* or halo |
| 13. #8 or #9 or #10 or #11 or #12 |
| 14. #7 and #13 |
| 15. trial* or randomi* |
| 16. double blind or placebo* |
| 17. meta-analys* or metaanalyls* |
| 18. explode clinical trial/ all subheading |
| 19. explode controlled study/ all subheadings |
| 20. control* |
| 21. #15 or #16 or #17 or #18 or #19 or #20 |
| 22. #21 and #14 |
| 23. human in de |
| 24. nonhuman in de |
| 25. #24 not (#24 and #23) * |
| 26. #22 not #25 |

CINAHL (1982-2000.3)

| 1. (spine or spine or cervix or cervical or lumbar or thorac*) in ti,ab,de |
| 2. (neck or whiplash) in ti,ab,de |
| 3. (immobil* or mobility) in ti,de,ab |
| 4. (stabil* or stable or collar*) in ti,de,ab |
| 5. (backboard* or vacuum splint* or neutral position* or strapping or strapped or straps or spine board* or tapes or taping) in ti,de,ab |
| 6. (headblock* or sandbag* or (kendrick in ti,ab) or orthodos* or orthotic* or brace*) in ti,ab,de |
| 7. (spine board or splint* or halo) in ti,de,ab |
| 8. (trial* or randomi* or double blind or placebo*) in ti,ab,de |
| 9. (meta-analys* or metaanalyls* or control*) in de,ti,ab |
| 10. #1 or #2 |
| 11. #5 or #6 or #7 |
| 12. #8 or #9 |
| 13. #10 and #11 and #12 |

Table 2. Table of randomised controlled trials on healthy volunteers

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<th>Authors</th>
<th>Title</th>
<th>Type of study</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
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<td>Black 1998</td>
<td>Comparative study of risk factors for skin breakdown with cervical orthotic devices: Philadelphia and Aspen</td>
<td>Randomised controlled trial</td>
<td>20 healthy volunteers</td>
<td>Philadelphia collar vs Aspen Collar</td>
<td>Skin breakdown</td>
<td>No significant difference in occipital pressure and skin temperature between collars. Significant increase in relative skin humid-</td>
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Spinal immobilisation for trauma patients (Review)
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Table 2. Table of randomised controlled trials on healthy volunteers (Continued)

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<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Interventions</th>
<th>Outcomes</th>
</tr>
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<tbody>
<tr>
<td>Chan 1996</td>
<td>Comparative study of risk factors for skin breakdown with cervical orthotic devices: Philadelphia and Aspen</td>
<td>Randomised controlled trial</td>
<td>37 healthy volunteers</td>
<td>StifNeck collar + Standard backboard vs StifNeck collar + Vacuum mattress splint</td>
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<tr>
<td>Cline 1985</td>
<td>Comparative study of risk factors for skin breakdown with cervical orthotic devices: Philadelphia and Aspen</td>
<td>Randomised controlled trial</td>
<td>97 healthy volunteers</td>
<td>Philadelphia collar vs Philadelphia collar + short board vs Hare extrication collar vs Hare extrication collar + short board vs rigid plastic collar vs rigid plastic collar + short board vs short board only</td>
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<tr>
<td>Cordell 1995</td>
<td>Pain and tissue-interface pressures during spine-board immobilisation</td>
<td>Randomised controlled trial</td>
<td>20 healthy volunteers</td>
<td>Collar + Spine board with air mattress vs Collar + Spine board without mattress</td>
</tr>
<tr>
<td>Graziano 1987</td>
<td>A radiographic comparison of prehospital cervical immobilisation methods</td>
<td>Randomised controlled trial</td>
<td>45 healthy volunteers</td>
<td>StifNeck Collar vs Short board technique vs Kendrick Extrication Collar</td>
</tr>
</tbody>
</table>
Table 2. Table of randomised controlled trials on healthy volunteers (Continued)

| Hamilton 1996 | The efficacy and comfort of full-body vacuum splints for cervical immobilisation | Randomised controlled trial | 26 healthy volunteers | Stifneck collar + backboard vs Backboard vs Stifneck collar + vacuum splint vs Vacuum splint | Degree of immobilisation efficacy and comfort | Significant increase in immobilisation efficacy and comfort with the vacuum splint (P<0.05) |
| Johnson 1996 | Comparison of a vacuum splint device to a rigid backboard for spinal immobilisation | Randomised controlled trial | 30 paramedic students | Collar + vacuum splint vs Collar + backboard vs Vacuum splint only vs Backboard only | Degree of immobilisation, comfort and speed of application | No significant difference in degree of immobilisation with the vacuum splint and the backboard, with or without collar. Significant faster application with the vacuum splint than the backboard (P<0.001). Significant improvement in comfort with the Vacuum splint (P<0.001). |
| Lerner 1998 | The effects of neutral positioning with and without padding on spinal immobilisation of healthy subjects | Randomised controlled trial | 39 healthy volunteers | Collar + backboard with occipital padding vs Collar + backboard without occipital padding | Incidence and severity of pain | No significant decrease in incidence and severity of pain between padded and unpadded wooden backboard |
| Lunsford 1994 | The effectiveness of four contemporary cervical orthosis in re... | Randomised controlled trial | 10 healthy volunteers | No collar vs Philadelphia collar | Degree of cervical motion measured with video frames | Significant reduced motion with each orthosis than 'no or-
<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
<th>Design</th>
<th>Participants</th>
<th>Interventions</th>
<th>Efficacy</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>Perry 1999</td>
<td>The efficacy of head immobilisation techniques during simulated vehicle motion</td>
<td>Randomised controlled trial</td>
<td>6 healthy volunteers</td>
<td>StifNeck collar + roller towel + fracture board vs StifNeck collar + headbed + fracture board vs StifNeck collar + wedge + fracture board</td>
<td>Efficacy of head immobilisation techniques</td>
<td>No effect in eliminating head movements with any of these techniques</td>
</tr>
<tr>
<td>Totten 1999</td>
<td>Respiratory effects of spinal immobilisation</td>
<td>Randomised crossover trial</td>
<td>39 healthy volunteers</td>
<td>Vacuum collar + vacuum mattress vs StifNeck collar + wooden board</td>
<td>Respiratory effects</td>
<td>Significant respiratory restriction with whole-body spinal immobilisation compared with baseline (P&lt;0.001). No significant difference in respiratory restriction with both wooden board and vacuum mattress</td>
</tr>
<tr>
<td>Delbridge 1993</td>
<td>Discomfort in healthy volunteers immobilised on wooden backboards and vacuum mattress splints (Abstract)</td>
<td>Randomised controlled trial</td>
<td>12 healthy volunteers</td>
<td>Wooden backboard vs Vacuum mattress splint</td>
<td>Degree of discomfort</td>
<td>Significantly less discomfort with vacuum mattress splints (P&lt;0.05)</td>
</tr>
<tr>
<td>Walton 1995</td>
<td>Padded vs unpadded spine board for cervical spine immobilisation</td>
<td>Randomised controlled trial</td>
<td>30 healthy volunteers</td>
<td>Foam-padded spine board vs Unpadded spine board</td>
<td>Comfort Immobilisation efficacy Sacral tissue oxygenation</td>
<td>Significantly less discomfort with padded spine board (P=0.024). No significance.</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Study Design</td>
<td>Participants</td>
<td>Intervention</td>
<td>Outcome</td>
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<tr>
<td>Mazolewski 1994</td>
<td>The effectiveness of strapping techniques in spinal immobilisation</td>
<td>Randomised controlled trial</td>
<td>19 healthy volunteers</td>
<td>Backboards with 4 torso strapping techniques</td>
<td>Significant improved lateral motion with addition of abdominal straps (P&lt;0.05)</td>
<td></td>
</tr>
<tr>
<td>Manix 1995a</td>
<td>Comparison of prehospital cervical immobilisation devices using video and electromyography</td>
<td>Randomised controlled trial</td>
<td>20 healthy volunteers</td>
<td>Corrugated board (A) vs Reusable foam board (B) vs Tape with towel rolls (C)</td>
<td>Significant motion restriction with A and C compared with B (P&lt;0.05)</td>
<td></td>
</tr>
<tr>
<td>Jedlicka 1999</td>
<td>A comparison of the effects of two methods of spinal immobilisation on respiratory effort in the older adult</td>
<td>Randomised controlled trial</td>
<td>57 older adult volunteers</td>
<td>Full length wooden backboard vs Vacuum immobilizer device</td>
<td>Significant increased respiratory effort with backboard (P&lt;0.05)</td>
<td></td>
</tr>
<tr>
<td>Hauswald 2000</td>
<td>A comparison of the effects of four methods of spinal immobilisation on ischaemic pain</td>
<td>Randomised controlled trial</td>
<td>22 adult volunteers</td>
<td>Traditional backboard vs Backboard padded with a folded blanket vs Backboard padded with a 3-cm gurney mattress vs Backboard and</td>
<td>Ischaemic pain Significant increase in comfort with padded backboards (P&lt;0.05)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Table of randomised controlled trials on healthy volunteers (Continued)

| Mattress padded with a 6-cm eggcrate foam pad |

**APPENDICES**

Appendix 1. Search strategy

**July 2007 update search strategies**

**INJURIES SPECIALISED REGISTER**

(spine or spinal) AND (immobile or immobilize or immobilization or stabil* or stable or brace or splint*)

**MEDLINE** 2007/June week 4

1. exp Spinal Injuries/
2. exp Spinal Cord Injuries/
3. ((spine or spinal or cervix or cervical or lumbar or thoraS) adj3 (injur$ or trauma$)).ab,ti.
4. whiplash.ab,ti.
5. or/1-4
6. exp Immobilization/
7. exp Orthotic Devices/
8. (backboard$ or vacuum splint$ or neutral position or strapping or strapped or straps or spine board$ or tapes or taping or log roll$).ab,ti.
9. (headblock$ or sandbag$).ab,ti.
10. or/6-9
11. 5 and 10
12. (randomised or randomized or randomly or random order or random sequence or random allocation or randomly allocated or at random or controlled clinical trial$).tw,hw.
13. clinical trial.pt.
14. 12 or 13
15. exp models, animal/
16. exp Animals/
17. exp Animal Experimentation/
18. exp Disease Models, Animal/
19. exp Animals, Laboratory/
20. or/15-19
21. Humans/
22. 20 not 21
23. 14 not 22
24. 11 and 23

**EMBASE** 2007/ week 27

1. exp Spinal Cord Injury/
2. exp Spine Injury/
3. ((spine or spinal or cervix or cervical or lumbar or thoraS or neck) adj5 (injur$ or trauma$)).ab,ti.
4. whiplash.ab,ti.
5. or/1-4
6.exp IMMOBILIZATION/
7.exp ORTHOTICS/
8.(backboard$ or vacuum splint$ or neutral position or strapping or strapped or straps or spine board$ or tapes or taping).ab,ti.
9.(headblock$ or sandbag$ or orthosis or orthotic or brace$ or splint).ab,ti.
10.(immobili$ or mobility or stabili$ or collar$ or log roll$).ab,ti.
11.or/6-10
12.5 and 11
13.exp animal model/
14.Animal Experiment/
15.exp ANIMAL/
16.exp Experimental Animal/
17.13 or 14 or 15 or 16
18.Human/
19.17 not 18
20.(randomised or randomized or randomly or random order or random sequence or random allocation or randomly allocated or at random or controlled clinical trial$).tw,hw.
21.exp clinical trial/
22.20 or 21
23.22 not 19
24.12 and 23

Central 2007, issue 2 and National Research Register 2007, issue 2
#1MeSH descriptor Spinal Injuries explode all trees #2MeSH descriptor Spinal Cord Injuries explode all trees
#3injur* and (spine or spinal or cervix or cervical or lumbar or thora* or neck)
#4trauma* and (spine or spinal or cervix or cervical or lumbar or thora* or neck)
#5whiplash
#6(#1 OR #2 OR #3 OR #4 OR #5)
#7MeSH descriptor Immobilization explode all trees
#8MeSH descriptor Orthotic Devices explode all trees
#9immobili* or mobility or stabili* or collar* or orthotic or orthosis or brace* or splint*
#10backboard* or vacuum splint* or neutral position or strapping or strapped or straps or spine board* or tapes or taping or log roll*
#11headblock* or sandbag*
#12(#7 OR #8 OR #9 OR #10 OR #11)
#13(#6 AND #12)
#14(#13), from 2003 to 2007

(spine or spinal) AND ( immobile OR immobilize or immobilization or stabilize or stable or brace or splint ) [ALL-FIELDS]

ZETOC
Searches 11-07-07
spinal* immobil* trial*
or
spine* immobil* trial*
or
spinal immobil* random*
or
spine* immobil* random*
WHAT'S NEW
Last assessed as up-to-date: 30 June 2007.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 September 2008</td>
<td>Amended</td>
<td>Converted to new review format.</td>
</tr>
</tbody>
</table>

HISTORY
Review first published: Issue 2, 2001

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 August 2007</td>
<td>New search has been performed</td>
<td>August 2007 An updated search was conducted in July 2007. No new randomised controlled trials comparing spine immobilisation strategies in trauma patients with suspected spinal cord injury were identified</td>
</tr>
</tbody>
</table>

CONTRIBUTIONS OF AUTHORS
IK helped to design the protocol, examined search results, applied inclusion criteria and wrote the review. FB examined search results, applied inclusion criteria, and helped to write the review. IR commented on the protocol and helped to write the review.

DECLARATIONS OF INTEREST
None known.

SOURCES OF SUPPORT
Internal sources
- Institute of Child Health, University of London, UK.
External sources

- Global Programme on Evidence for Health Policy (GPE), World Health Organisation, Switzerland.

INDEX TERMS

Medical Subject Headings (MeSH)

*Immobilization; *Spinal Cord Injuries; Spinal Injuries [*complications]

MeSH check words

Humans