

## BEST EVIDENCE TOPIC REPORTS

## Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary

Edited by K Mackway-Jones

Best evidence topic reports (BETs) summarise the evidence pertaining to particular clinical questions. They are not systematic reviews, but rather contain the best (highest level) evidence that can be practically obtained by busy practising clinicians. The search strategies used to find the best evidence are reported in detail in order to allow clinicians to update searches whenever necessary.

The BETs published below were first reported at the Critical Appraisal Journal Club at the Manchester Royal Infirmary.<sup>1</sup> Each BET has been constructed in the four stages that have been described elsewhere.<sup>2</sup> The BETs shown here together with those published previously and those currently under construction can be seen at <http://www.bestbets.org>.<sup>3</sup> Five topics are covered in this issue of the journal.

1 Carley SD, Mackway-Jones K, Jones A, *et al*. Moving towards evidence based emergency medicine: use of a structured critical appraisal journal club. *J Accid Emerg Med* 1998;15:220-2.

2 Mackway-Jones K, Carley SD, Morton RJ, *et al*. The best evidence topic report: A modified CAT for summarising the available evidence in emergency medicine. *J Accid Emerg Med* 1998;15:222-6.

- Oral or intravenous  $\beta$  blockers in acute myocardial infarction
- Nasal diamorphine for acute pain relief in children
- Does a normal CT scan rule out a subarachnoid haemorrhage?
- Mydriatics in corneal abrasion
- Midazolam and emergence phenomena in children undergoing ketamine sedation

In addition two prehospital topics are also covered.

- Cervical collars in patients requiring spinal immobilisation
- The prehospital use of pneumatic anti-shock garments

3 Mackway-Jones K, Carley SD. [bestbets.org](http://www.bestbets.org): Odds on favourite for evidence in emergency medicine reaches the worldwide web. *J Accid Emerg Med* 2000;17:235-6.

### Oral or intravenous $\beta$ blockers in acute myocardial infarction

Report by Steve Jones, *Clinical Research Fellow*  
Search checked by Ian Crawford, *Clinical Research Fellow*

#### Clinical scenario

A 45 year old man is brought to the emergency department with acute, central chest pain. You have diagnosed an acute myocardial infarction from the ECG for which he is receiving thrombolysis. You know that giving him a  $\beta$  blocker will improve his outcome but you only have tablets in the department and wonder whether he will be at a disadvantage for receiving this rather than an intravenous dose.

#### Three part question

In [an acute myocardial infarction] is [IV  $\beta$  block better than oral  $\beta$  block] at [reducing mortality and decreasing morbidity]?

#### Search strategy

Medline 1966-12/00 using the OVID interface. [{exp myocardial infarction OR myocardial infarction.mp} AND {exp adrenergic

beta-antagonists OR beta blockers.mp} AND {exp administration, oral OR exp oral medicine OR oral.mp}] AND maximally sensitive RCT filter LIMIT to human AND english.

#### Search outcome

Altogether 143 papers found of which 142 were irrelevant or of insufficient quality. The remaining paper is shown in table 1.

#### Comments

Although atenolol seems to improve outcomes after thrombolysis for myocardial infarction, early intravenous atenolol seems of limited value. The best approach for most patients may be to begin oral atenolol once stable. More work will need to be done.

#### Clinical bottom line

Oral  $\beta$  blockers are better than IV  $\beta$  blockers in stable AMI patients.

1 Pfisterer M, Cox JL, Granger CB, *et al*. Atenolol use and clinical outcomes after thrombolysis for acute myocardial infarction: the GUSTO-I experience. Global Utilization of Streptokinase and TPA (alteplase) for Occluded Coronary Arteries. *J Am Coll Cardiol* 1998;32:634-40.

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Table 1

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Pfisterer M <i>et al</i> , Switzerland, 1998	Patients with acute MI No atenolol (n=10 073) <i>vs</i> any atenolol (n=30 771) Any intravenous atenolol (n=18 200) <i>vs</i> oral atenolol only (n=12 545) <i>v</i> both intravenous and oral drug (n=16 406)	Prospectively planned post hoc analyses of the GUSTO-I dataset (a multicentre PRCT)	Mortality any atenolol <i>v</i> none Mortality IV atenolol <i>vs</i> oral Morbidity	30 day mortality was significantly lower in atenolol treated patients. More likely to die (odds ratio 1.3 (95% CI 1, 1.5) p=0.02) More heart failure, shock, recurrent ischaemia and pacemaker use	

### Nasal diamorphine for acute pain relief in children

Report by Mark Davies, *Specialist Registrar*  
Search checked by Ian Crawford, *Clinical Research Fellow*

#### Clinical scenario

An 8 year old boy attends the emergency department after a fall at school. Clinically he has a displaced fracture of the right radius and ulna. He is in a lot of pain and so needs analgesia before radiography. You have heard of the use of nasal diamorphine for pain relief but wonder whether there is evidence to show whether it is as effective as injected morphine.

#### Three part question

[In children with acute pain] is [nasal diamorphine or injected morphine] better at [providing safe, acceptable and effective analgesia].

#### Search strategy

Medline 1966–01/01 using the OVID interface. [(exp heroin OR diamorphine.mp OR exp narcotics OR opioids.mp OR opiates.mp OR narcotics.mp) AND (exp nasal mucosa OR nasal.mp OR exp nose OR nose.mp OR exp administration, intranasal OR intranasal.mp)].

#### Search outcome

Altogether 303 papers found of which only one was relevant. An additional paper has recently been published and was not indexed on Medline at the time of searching. These two papers are shown in table 2.

#### Comments

These two papers would suggest that intranasal diamorphine is as effective as intramuscular morphine and is much better tolerated by children with no apparent increased risk of side effects. Further work comparing intranasal diamorphine with oral morphine would be useful.

#### Clinical bottom line

Nasal diamorphine is a safe and effective analgesic in children with acute musculoskeletal pain and is to be recommended.

- Wilson JA, Kendall JM, Cornelius P. Intranasal diamorphine for paediatric analgesia: assessment of safety and efficacy. *J Accid Emerg Med* 1997;14:70–2.
- Kendall JM, Reeves BC, Latter VS. Multicentre randomised controlled trial of intranasal diamorphine for analgesia for children and teenagers with clinical fractures. *BMJ* 2001;322: 261–5.

Table 2

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Wilson JA <i>et al</i> , UK, 1996	58 children age 3–16 with suspected limb fractures. 0.1 mg/kg nasal diamorphine <i>v</i> 0.2 mg/kg IM morphine	PRCT	Degree of analgesia at 5, 10, 20 and 30 min Proportion of children with no pain Parental satisfaction Side effects	No clinical or statistical difference 100 <i>v</i> 55% p<0.0001 none reported	Small numbers Not blinded
Kendall JM <i>et al</i> , UK, 2001	404 children aged 3 to 16 years with clinical fracture of an upper or lower limb. 0.1 mg/kg nasal diamorphine <i>v</i> 0.2 mg/kg IM morphine	PRCT	Degree of analgesia at 5 min 10 min 20 min 30 min Parental satisfaction Staff satisfaction Side effects	Less in nasal (p<0.04) Less in nasal (p<0.003) Less in nasal (p<0.002) No significant difference Greater in nasal (p<0.0001) Greater in nasal (p<0.0001) Nil serious reported	Clinical significance of different analgesic effect not reported

### Does a normal CT scan rule out a subarachnoid haemorrhage?

Report by Simon Carley, *Specialist Registrar*  
Search checked by Paul Wallmann, *Specialist Registrar*

#### Clinical scenario

A 24 year old man who has been previously well presents to the emergency department complaining of headache. He describes the headache as the worst he has ever had. It came on

Table 3

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
MacDonald A and Mendelow AD, Scotland, 1987	100 patients with diagnosis of SAH confirmed on angiography in tertiary centre	Retrospective chart review	Sensitivity of CT	99 patients had had a CT, of these 20 were normal. Sensitivity = 80% (CI=15, 25%)*	This paper did not specifically address the original question. It is subject to referral bias as only patients in a tertiary centre were examined. The CT scanners used at this time were early models.
Van der Wee N <i>et al</i> , Netherlands, 1994	175 consecutive patients with clinical suspicion of SAH. Patients with negative CT then went on to have LP. CT was performed immediately, LP after 12 hours from headache onset.	Retrospective chart review	Sensitivity for CT	117 patients had blood on CT. Of the other 58 patients, 2 had positive LP. Overall sensitivity for CT = 95% (CI=94, 98.8%)	Not all patients had an LP. If the gold standard is LP findings then some of the CT cases may represent false positives.
Sames TA <i>et al</i> , USA, 1996	181 patients with SAH confirmed by LP, angiography, surgery or necropsy who had a CT prior to definitive diagnosis. Only 3rd generation scanners included	Retrospective chart review	Overall sensitivity Sensitivity at less than 24 hours after symptoms Sensitivity at more than 24 hours after symptoms	91.2% (CI=87, 95%) 93.1% 83.8%	Retrospective design. There were 349 patients meeting entry criteria but 92 sets of notes were unavailable for review.
Sidman R <i>et al</i> , USA, 1996	140 patients with a diagnosis of non-traumatic SAH  LP findings used as gold standard for diagnosis	Retrospective chart review	Overall sensitivity  Sensitivity of CT at less than 12 hours after symptoms Sensitivity of CT more than 12 hours after symptoms	11/140 (92.1% sensitivity) of patients had normal CT and positive LP. 80/80 patients had positive CT and positive LP (100% sensitivity CI 95, 100%) 49/60 had positive CT and positive LP (81.7% sensitivity CI 69.5, 90.4%)	Retrospective design
Lachtaw RE <i>et al</i> , USA, 1997	Review article	Review article	Sensitivity of CT	Sensitivity of CT ranges from 95–98%. Sensitivity decreases with time (58% at 5 days, 50% at 1 week)	Original data from studies is not presented. Not a systematic review.
Morgenstein LB <i>et al</i> , USA, 1998	107 patients with worst headache ever. Patients with negative CT got LP. Scans were reviewed by 2 neuroradiologists blinded to the LP results. LP findings used as gold standard for diagnosis	Retrospective case note and radiology review.	Number of patients with normal CT but positive LP.	2 of 89 patients with normal CT had positive LP. Sensitivity given at 97.5% (CI 97.8%, 88.7%)	Retrospective design. Not all patients with positive CT had an LP performed.

suddenly approximately two hours previously and has not resolved with paracetamol. It was so severe as to cause him to collapse when it started. He has no other neurological symptoms and clinical examination reveals no neurological signs. You are concerned that he may have had a sub-arachnoid haemorrhage and arrange a CT scan. The scan is reported as normal. You wonder if this rules out the diagnosis of subarachnoid haemorrhage in your patient.

#### Three part question

[In patients presenting with a history of sudden severe headache] is [CT scanning alone as good as CT scanning plus lumbar puncture] in ruling out [sub-arachnoid haemorrhage].

#### Search strategy

Medline 1966–12/00 using the OVID interface. [(exp subarachnoid haemorrhage OR subarachnoid.mp) AND (cerebrospinal fluid OR spinal fluid.mp OR exp spinal puncture OR lumbar puncture.mp OR xanthochromia.mp) AND (exp tomography, x-ray computed OR ct.mp OR computed tomography.mp)] LIMIT to human, english AND abstracts.

#### Search outcome

Altogether 140 papers found of which 134 were irrelevant and of insufficient quality for inclusion. The remaining six papers are shown in table 3.

#### Comments

Emergency physicians need to know if CT is sensitive enough to rule out the diagnosis of subarachnoid bleeding in patients presenting with severe headache. Subarachnoid haemorrhage is an important diagnosis to make, the risk of re-bleeding is high if the initial bleed is missed and it is a condition for which treatment is possible. We must therefore err on the side of caution and seek investigations with a very high sensitivity to rule out the diagnosis. The use of lumbar puncture (LP) as a gold standard in many of these studies can be questioned as it too has a false negative rate, particularly when performed soon after a bleed. The diagnosis of subarachnoid haemorrhage is so important that sensitivity must approach 100% for CT to obviate the need for LP. The current trials found reveal two interesting facts. (1) That CT has a high sensitivity (91–98%) for detecting subarachnoid haemorrhage, though this is not high enough to satisfactorily exclude subarachnoid haemorrhage. (2) That the sensitivity of CT for subarachnoid haemorrhage decreases with time.

The sensitivity given in the more recent trials is approximately 95%. This is not high enough to rule out subarachnoid haemorrhage. It is more sensitive the earlier it is performed, this is the converse of LP. The advantage of CT is that it quick and easy to perform, may be positive in the early stages of subarachnoid haemorrhage and it may give information on the cause or size of the bleed. It may also exclude a space occupying lesion.

*Clinical bottom line*

Patients with lone acute severe headache should have urgent CT; if this is negative then a LP should be performed.

- 1 Macdonald A, Mendelow AD. Xanthochromia revisited: a re-evaluation of lumbar puncture and CT scanning in the diagnosis of subarachnoid haemorrhage. *J Neurol Neurosurg Psychiatry* 1988;51:342-4.
- 2 Van der Wee N, Rinkel GJE, Hasan D, et al. Detection of subarachnoid haemorrhage on early CT: is lumbar puncture still needed after a negative scan? *J Neurol Neurosurg Psychiatry* 1995;58:357-9.

- 3 Sames TA, Storrow AB, Finkelstein JA, et al. Sensitivity of new-generation computed tomography in sub-arachnoid hemorrhage. *Acad Emerg Med* 1996;3:16-20.
- 4 Sidman R, Connolly E, Lemke T. Subarachnoid haemorrhage: lumbar puncture is still needed when computerised tomography scan is normal. *Acad Emerg Med* 1996;3:827-31.
- 5 Latchaw RE, Silva P, Falcone SF. The role of CT following aneurysmal rupture. *Neuroimaging Clin N Am* 1997;7:693-708.
- 6 Morgenstern LB, Luna-Gonzales H, Huber JC Jr, et al. Worst headache and subarachnoid hemorrhage: prospective, modern computed tomography and spinal fluid analysis. *Ann Emerg Med* 1998;32:297-304.

**Mydriatics in corneal abrasion**

Report by Fiona Carley, *Specialist Registrar Ophthalmology*  
 Search checked by Simon Carley, *Specialist Registrar*

*Clinical scenario*

A 20 year old man presents to the emergency department with a history of something having blown into his eye. Clinical examination reveals a small abrasion to the cornea. You prescribe chloramphenicol ointment and discharge the patient. A friendly ophthalmologist suggests that you should have given a dilating drop as well. You wonder if there is any evidence to support this.

*Three part question*

[In patients with simple corneal abrasions] is [a cycloplegic better than simple lubrication] at [reducing pain and discomfort]?

*Search strategy*

Medline 1966-12/00 using the OVID interface. [(exp cornea OR exp eye injuries OR corneal abrasion.mp) AND (exp mydriatics OR cycloplegics.mp OR exp cyclopentolate OR

cyclopentolate.mp OR exp atropine OR homatropine.mp OR exp tropicamide OR tropicamide.mp)] LIMIT to human, english AND abstracts.

*Search outcome*

Altogether 98 papers found of which 97 were irrelevant or of insufficient quality. The remaining paper is shown in table 4.

*Comments*

The use of cycloplegics/mydriatics is traditional and common practice for the treatment of corneal abrasions. However, there is no good evidence to support this. The only study pertinent to the three part question is flawed because of poor follow up and a number of compounding factors. However, even this study found no benefit to mydriatics (homatropine 2%).

*Clinical bottom line*

Cycloplegics cannot be recommended for use in patients with corneal abrasion.

- 1 Brahma AK, Shah S, Hillier VF, et al. Topical analgesia for superficial corneal injuries. *J Accid Emerg Med* 1996;13:186-8.

Table 4

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Brahma AK et al UK, 1996	401 patients with corneal abrasion Lubrication alone v 2% homatropine (single dose) v flubiprofen 0.03% QDS v flubiprofen 0.03% qds and homatropine stat	PRCT	Difference in pain score over 24 hour period and use of oral analgesia	No difference between homatropine and simple lubrication. No difference between the 2 groups receiving flubiprofen	Only 55% of patients followed up. All patients also received chloramphenicol ointment. Study not blinded

**Midazolam and emergence phenomena in children undergoing ketamine sedation**

Report by Simon Carley, *Specialist Registrar*  
 Search checked by Bruce Martin, *Specialist Registrar*

*Clinical scenario*

A 4 year old boy presents to the emergency department with a 4 cm laceration to the thigh. This requires cleaning and layered suture closure. You decide to sedate him using ketamine intramuscularly. You are successful and close the wound. However, while he is

recovering he seems to be experiencing unpleasant hallucinations. You wonder whether a small dose of midazolam given with the ketamine would have prevented this.

*Three part question*

[In children undergoing ketamine sedation in the emergency department] is [benzodiazepines plus ketamine better than ketamine alone] at [reducing emergence phenomena and minimising complications and time of sedation]?

Table 5

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Sherwin TS <i>et al</i> , USA, 2000	104 children aged 1–15 years. 68% had orthopaedic injuries and 30% had wounds. Ketamine 1.5 mg/kg <i>v</i> ketamine 1.5 mg/kg plus midazolam 0.05 mg/kg 2 min later	PRCT	Time to discharge Adequacy of sedation Emergence phenomena	96 min <i>v</i> 105 min (not significant) 64% <i>v</i> 61% (not significant) No difference	Large age range. No data on IM ketamine use. Low power for low incidence complications.
Wathen JE <i>et al</i> , USA, 2000	266 patients aged 4 months to 18 years. 65% had fractures and 25% had lacerations. Ketamine 1 mg/kg plus glycopyrrolate 5 microgram/kg (137) <i>v</i> Ketamine 1 mg/kg plus glycopyrrolate 5 microgram/kg plus midazolam 0.1 mg/kg	PRCT	Distress (Observational score of behavioural distress) Total sedation time Adverse events Physician satisfaction Parental satisfaction	No difference 78 min <i>v</i> 70 min (not significant) Less vomiting (19.4% <i>v</i> 9.6%) and nightmares (0% <i>v</i> 3.1%) with midazolam No difference No difference	Large age range. No data on IM ketamine use. Low power for low incidence complications.

#### Search strategy

Medline 1966–02/01 using the OVID interface. [(exp ketamine OR ketamine.mp) AND (exp benzodiazepines OR benzodiazepines.mp OR exp midazolam OR midazolam.mp OR exp diazepam OR diazepam.mp OR VERSED.mp OR exp lorazepam OR lorazepam.mp OR hyponotics and sedatives.mp OR hypnovel.mp) AND (child.mp OR children.mp)] LIMIT human, english AND abstracts.

#### Search outcome

Altogether 71 papers found of which only one was relevant. An additional paper has recently been published and was not indexed on Medline at the time of searching. These two papers are shown in table 5.

#### Comments

These two well designed studies investigate the question directly. There seems to be no advantage in the addition of midazolam for IV ketamine sedation. Its use in IM ketamine sedation may be different as the pharmacokinetics of both drugs may be different via the IM route.

#### Clinical bottom line

Midazolam is not needed as an adjunct to ketamine sedation in children.

- 1 Sherwin TS, Green SM, Khan A, *et al*. Does adjunctive midazolam reduce recovery agitation after ketamine sedation for pediatric procedures? A randomized double blind placebo controlled trial. *Ann Emerg Med* 2000;35:229–38.
- 2 Wathen JE, Roback MG, Mackenzie T, *et al*. Does midazolam alter the clinical effects of intravenous ketamine sedation in children? A double blind randomized controlled emergency department trial. *Ann Emerg Med* 2000;36:579–88.

### The prehospital use of pneumatic anti-shock garments

Report by Ian Crawford, *Clinical Research Fellow*

Search checked by Angaj Ghosh, *Senior Clinical Fellow*

#### Clinical scenario

You are the doctor on scene of a road traffic accident attending a 30 year old man who has sustained blunt trauma to the abdomen. Systolic BP is 70 mm Hg despite resuscitation. Someone suggests using the pneumatic anti-shock garment (PASG). You cannot remember from your recent ATLS course whether this can be used to support blood pressure in hypotensive patients. You wonder if PASG use

has been shown to have any effect on mortality.

#### Three part question

In [a hypotensive trauma victim] does [the use of PASG/MAST] reduce [mortality, length of hospital stay or length of time spent in ICU]?

#### Search strategy

Medline 1966–12/00 using the OVID interface AND cochrane database. {(exp g suits OR g suit.mp OR pneumatic antishock garment.mp OR military antishock trouser\$.mp OR PASG.mp OR MAST suit.mp) AND (exp wounds and injuries OR trauma\$.mp) AND

Table 6

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Dickinson K and Roberts I, UK, 1999	2 prospective randomised controlled trials including 1202 patients  Adults >15 years with blunt or penetrating injuries and a systolic BP ≤90 mm Hg. Patients excluded where PASG was only used for fracture splinting. PASG <i>v</i> no PASG	Meta-analysis	Overall mortality  Length of hospital stay  Length of time spent in ICU	Pooled relative risk of mortality for patients randomised to PASG group was 1.13 (95% CI 0.97, 1.32) No reduction in length of hospital stay No reduction in length of time spent in ICU	Poor quality allocation concealment in both trials  Loss of 14% of patients from one trial with disparity in the two groups

maximally sensitive RCT filter}] LIMIT to human AND english.

*Search outcome*

Altogether 68 papers were found of which 66 were irrelevant. Both of the two relevant papers had been meta-analysed by the Cochrane Injuries Group (table 6).

*Comments*

The use of PASG may actually be associated with an increase in overall mortality in

hypotensive patients after trauma. In addition, no reduction was demonstrated in length of hospital stay or length of time spent in ICU.

*Clinical bottom line*

The use of PASG in hypotensive patients following trauma cannot be supported.

1 Dickinson K, Roberts I. Medical anti-shock trousers (pneumatic anti-shock garments) for circulatory support in patients with trauma (Cochrane Review). In: *The Cochrane Library*. Issue 1, 2001. Oxford: Update Software.

**Cervical collars in patients requiring spinal immobilisation**

Report by John Butler, *Specialist Registrar*  
Search checked by Damien Bates, *Specialist Registrar*

*Clinical scenario*

A paramedic crew brings a 27 year old patient with a suspected cervical spine injury to the emergency department after an RTA. At the scene of the accident the patient had full spinal immobilisation, which consisted of a long spinal board, a correctly sized cervical collar, and head blocks with straps to secure the head to the board. In the emergency department the patient is becoming increasingly distressed by the presence of the neck collar and requests that it is removed. You wonder whether the cervical collar provides any additional benefit in terms of immobilising the spine.

*Three part question*

In [patients requiring full spinal immobilisation] is [the use of a cervical collar, long board and head blocks better than long board and head blocks alone] at [cervical spinal immobilisation]?

*Search strategy*

Medline 1966–03/01 using the OVID interface and hand searching relevant pre-hospital journals. {(exp spinal injuries OR spinal injury\$.mp OR back injuries OR back injury\$.mp

OR exp neck injuries OR neck injury\$.mp OR exp spinal cord injuries OR spinal cord injury\$.mp OR exp spinal fractures OR spinal fracture\$.mp OR exp lumbar vertebrae OR lumbar spine injury\$.mp OR exp thoracic vertebrae OR thoracic spine injury\$.mp OR exp cervical vertebrae OR vertebral fracture\$.mp OR cervical spinal injury\$.mp OR exp multiple trauma OR multiple trauma.mp OR exp wounds and injuries OR trauma.mp) AND (exp immobilization OR spine boards\$.mp OR neck collar\$.mp OR spinal immobilization\$.mp OR cervical collar\$.mp OR hard collar\$.mp OR semi-rigid collar\$.mp OR rigid collar\$.mp)} LIMIT to human AND english.

*Search outcome*

Altogether 855 papers found of which 854 were irrelevant or of insufficient quality. The remaining paper is shown in table 7.

*Comments*

There is no evidence of the effect in patients with cervical spinal injuries. Furthermore, goniometric techniques do not assess the movement at an individual vertebral level.

*Clinical bottom line*

Cervical collars are of no additional benefit to patients already immobilised using a long spine board with straps.

1 Houghton L, Driscoll P. Cervical immobilization—are we achieving it? *Prehosp Immed Care* 1999;3:17–21.

Table 7

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Houghton L and Driscoll P, UK, 1999	24 healthy volunteers. Two different cervical collars with and without head blocks and straps. Movement was assessed using goniometric techniques.	Clinical trial	Percentage neck movement	Collars produced a reduction of movement of 31–45%. Head blocks and straps produced a reduction of between 58–64%. When head blocks and straps were in place the addition of a collar was not beneficial.	Goniometric techniques can overestimate the actual cervical spine movement.