Title

Incidence and management of cervical spine injuries in fatal road traffic accidents

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Abstract

Cervical spine injuries are common in road trauma and resultant damage can be noted through imaging or replicated in biomechanical studies, all of which have limitations. This study provides a unique and important opportunity to correlate prehospital cervical spine treatment with detailed post-mortem cervical spine dissection.

Twenty-five of 159 victims of fatal road trauma occurring in a five-month period were treated by ambulance and hospital staff. Cervical injury was sustained by 15 of the victims; injury involved all structures in the cervical spine. The greatest incidence of injury was to the upper cervical motion segments with intramuscular haemorrhage (especially at C1-2) the most frequently seen.

Treatment was divided into pre-hospital and hospital care. The primary mode of pre-hospital treatment for cervical trauma was the Vertebrace extrication collar, a specialised cervical collar. The Vertebrace was used in 88% of victims while supplementary supports were employed in 79% of cases. Only 56% of patients underwent cervical x-rays during hospital treatment and a number of these films unsatisfactorily visualised the spine. No correlation between age, gender, blood alcohol, road user or crash characteristics and injury was ascertained, but this may have been due to the sample size and indicates the need for further study in this area.

Keywords

Cervical spine, pre-hospital, trauma, management

Body of Paper

Introduction

In 1997, the year preceding this study, the expected national Australian road toll was 1735 (Australian Transport Council 2008) between 10% and 24% of whom were estimated to sustain a cervical spine injury (Cain, Ryan et al. 1989; Traynelis and Gold 1993).

Cervical spine injury may occur as a consequence of sporting, diving or motor vehicle trauma and as such has the potential to affect a large cross-section of the community. Reflective of the size and complexity of the problem presented by cervical injury, this study chose to narrow its parameters by focusing on cervical injuries sustained in road traffic trauma. The population was further qualified by only accepting those subjects who had received treatment by both ambulance and hospital staff. Previous studies of cervical road trauma have focused on mechanical testing, mathematical and animal modelling and retrospective treatment and autopsy analysis (Nightingale, McElhaney et al. 1996; Wilmink, Samra et al. 1996; McDermott, Cordner et al. 2000; Ryan, Stella et al. 2004). The current study also completed a retrospective analysis, reviewing police, ambulance and hospital reports. It further undertook a unique extension of the autopsy by including post-mortem x-rays and cervical spine dissection thereby increasing the amount of data available for comparison.

This article focuses on the anatomical injuries that were sustained in road trauma, but, importantly, it reviews facets of the Haddon Matrix in light of these injuries to ascertain future direction. The Haddon Matrix provides a nine-cell systems approach to road trauma, however the focus here will be on the human and vehicle crash components (e.g. impairment and restraints) and human post-crash components (e.g. ambulance intervention) (Pedsen, Scurfield et al. 2004).

Methods

All road traffic fatalities that occur in Victoria are reported to the State Coroner and the majority of these are autopsied at the Victorian Institute of Forensic Medicine (a small number are autopsied at regional hospitals). A full autopsy is performed on all reported cases, in accordance with the 1985 Victorian Coroner's Act. The exception is when, under Section 29 of the Act, the family lodge an objection to an autopsy and this is accepted by the Coroner.

When a body arrives at the mortuary it is accompanied by the police report (Form 83), ambulance and medical records. The Coroners' office allocates a case number, and then the body is weighed, measured and admitted by a technician. Details from the police report are entered into the computer system. A blood sample is taken, which is analysed (by the serology department) for HIV antibodies and antigens to Hepatitis B and C viruses (HBV and HCV). If any of these are detected, the body is considered bio-hazardous and is subsequently precluded from having tissues taken for research purposes.

Bodies are stored in refrigerated rooms with a constant temperature of 4°C while awaiting autopsy; autopsy is usually carried out within 24 hours of admission.

Ethics approval for this study was given by the University of Melbourne's Ethics committee and permission was given to use human tissue, collected at the Victorian Institute of Forensic Medicine (VIFM).

The police and ambulance reports and medical records were all reviewed. This allowed an amended version of the questionnaire used by the Transport Accident Commission (TAC) Consultative Committee on Road Traffic Accidents, to be completed. All other information regarding relevant treatment received by the patient was also recorded. The multiple sources used to collect this data ensured that the information collated was as accurate as possible without attending the site of each accident.

Initial analysis of the body was undertaken radiographically. The body was placed in the supine position on the x-ray table; all tubes and bandages left *in situ*. When the neck was not in a suitable position for the x-ray, it was extended slightly by placing a 'head block' between the shoulder blades, but care was taken not to cause any further damage during this procedure. Two x-rays were performed: a lateral and antero-posterior.

Results

A total of 159 consecutive cases of road traffic fatalities were reported within the five month period of this study (1st March and 31st July 1998).

Cases were excluded where the subject had died at the scene without receiving medical attention at a hospital (56%) although they may have been treated by ambulance and/or mobile intensive care ambulance officers (MICA officers). A further 9% were not autopsied due to the family lodging a Section 29, 1% was classified as a biohazard, 4% were death certificate inspections and 14% were classified 'other'. This classification included cases that fitted the criteria but were not included because the subject had survived for more than 30 days after the accident, the case had not been autopsied at VIFM or the pathologist had objected to the removal of the cervical spine. This left 16% (n=25) people who had suffered a fatal road accident, but survived long enough to receive medical treatment in a hospital, and therefore eligible for this study (see Appendix A).

Demographics of Subjects

Age categorisation of the sample indicated (n=25) the 66+ year old age group had the greatest representation, with those under the age of 20 years comprising the smallest proportion. Age ranged from 18 months to 92 years, with a mean and standard deviation of 50.78 years and 29.38 years, respectively (median=52 years). Sixteen of the sample was male, resulting in a 2:1.125 male to female ratio, which is higher than in most studies. The ratio in the total population was more normal (2.7:1). Therefore, the discrepancy in this study is probably due to the small sample size. Because of the large age range, height and weight were also highly variable and therefore were not analysed.

Blood Alcohol Concentration (BAC)

The legal limit for blood alcohol concentration for fully licensed drivers in Victoria is 0.05g/100 mL. Blood alcohol measurements were taken from 24 of the 25 subjects and collected either ante or post mortem, dependent upon the duration of hospitalisation. Of the 24 subjects that were tested one registered a BAC higher than the legal limit, while the remaining 23 had a BAC which was undetected.

Road User Characteristics

Appendix A describes the type of road user and position in the car, respectively, of those in the study sample. It shows that cars were the most common vehicle to be involved in fatal road trauma and the driver was at greatest risk. These results are skewed by the fact that cars are the most common vehicle on the roads and, obviously, drivers the most common occupants and do not take into account the proportionally higher risks for certain road users.

Crash Characteristics

Data relating to crash characteristics including mechanism of injury, velocity of impact, object of impact, protective devices and time of accident were only available for the current sample.

The most common injury mechanism was ‘knockdown’ involving the subject being struck by another moving vehicle. This is not unusual as it is the only method which applies to both pedestrians and other road users such as cyclists. Occupants and those who were entrapped in their vehicle accounted for five and seven subjects respectively. These two classifications were differentiated by whether or not the subject needed to be extricated from their vehicle. Rollovers, sideswipes, head-on collisions and ejections were each responsible for one fatality.

The velocity of the vehicle at the time of impact is difficult to determine and in a number of cases it was inferred by referring to the speed limit in the area in which the accident occurred. As such, this data provides little useful information because the majority of cases (19/25 or 76%) were estimated to have occurred at 60 km/hr or faster.

The objects, both mobile and stationary, with which the subject’s vehicle collided, were also recorded. Cars, because of their involvement in both directing and receiving force were the objects most frequently involved (14/25 or 56%). Trucks and 4-wheel-drive vehicles were involved in another four accidents (16%), while stationary objects (including a fence, trees, a light-pole, an embankment and a stump-muncher) were involved in the remaining 7 subjects (28%).

The use of protective devices to minimize injury only applied to 18 of the subjects – the remaining seven were pedestrians. In seven of the remaining 18 cases it was not possible to determine whether or not restraints or helmets had been used reducing the sample analysed for protective devices to eleven. Nine had used seatbelts and/or helmets and two had used no form of protective device. One of the subjects harnessed by a seatbelt was an eighteen month old child who should have been placed in an appropriate child restraint and, as a result, was ejected from the vehicle during the crash. Information regarding the presence of airbags in the vehicles involved was not available to the author.

The time at which the accident occurred, accurate to within 15 minutes, could be ascertained from police and ambulance reports. Only two subjects were involved in accidents that occurred at night (between 9 pm and 5 am), while the greatest proportion were injured in the morning, between 9 am and 12 noon (8/25 or 32%). Seven subjects had accidents in either the afternoon (12 noon–4 pm) or peak hours (7 am–9 am and 4 pm–7 pm).

Injury Characteristics

All injuries discovered during radiography and dissection were recorded in relation to the vertebral level at which they occurred.

Most injuries were sustained in the upper part of the cervical spine, in particular the C1-2 motion segment. The smallest number of injuries was recorded in the middle cervical spine with the lower cervical spine sustaining an intermediate number. The most common injury was extra-dural haemorrhage. Some of these could have been indirect head trauma, i.e. with blood tracking down into the cervical spine, rather than direct injury to the cervical spine itself. Therefore a more realistic interpretation of the data suggests that the most common injury was intramuscular haemorrhage. Bone injury including fractures, dislocations, and injuries to the facet joints were the least common type of injury. Nevertheless, the incidence of two fractures in a sample of 25 is still high.

Table 1 Number and type of injuries occurring at each level of the cervical spine.

Injury	C1	C2	C3	C4	C5	C6	C7	Total
Fracture	1	-	-	1	-	-	-	2
Dislocation	1	1	-	-	-	-	-	2
Cord Trauma	-	1	-	1	-	1	-	3
Disc injuries with haemorrhage	-	1	1	1	2	3	-	8
Intramuscular haemorrhage	10	9	5	5	5	6	4	44
R) vertebral artery trauma	1	2	2	2	2	2	2	13
L) vertebral artery trauma	3	3	3	2	2	2	2	17
Sub-dural haemorrhage	2	1	1	-	1	1	-	6
Extra-dural haemorrhage	7	7	7	5	5	5	5	41
Ligamentous injury	2	2	-	-	2	2	2	10
Facet Joint Injury		1	-	-	-	-	-	2
Total	28	28	19	17	19	22	15	148

Treatment

As part of this study, the treatment that the patients received from paramedics and hospital staff was also recorded. This treatment fell into two broad categories:

- the use of cervical supports and adherence to protocols regarding possible spinal injuries carried out by paramedics.
- the clearing of cervical injuries – radiographically – by hospital staff.

In the majority of cases, particularly with respect to the ambulance, these treatments were routinely followed. However, there were some instances where the management of a possible cervical injury was limited.

Table 2 Treatment received by patients from both ambulance and hospital staff.

Category	Numbers	Percentage
PREHOSPITAL TREATMENT		
With Vertebrace (inc rolled towels)	21/24	88%
With spinal board	19/24	79%
HOSPITAL TREATMENT		
Cervical x-rays (any one of anterior-posterior, lateral, PEG or swimmers)	14/25	56%
Had x-ray, but entire cervical spine not visualized	3/14	21%
Had a CT scan of cervical spine *	5/13	38%
An x-ray or CT scan was asked for or ambulance diagnosis suggested one should have been done, but wasn't **	3/11	18%
Not x-rayed and survived > 24 hours	1/25	4%

* CT scans only performed on patients that had already had an x-ray
** All had serious head injuries and survived for < 17 hours

Discussion

The initial aim of this study was to determine the effect of pre-hospital and hospital medical intervention on cervical injuries. Very few patients who sustained significant injury to the cervical spine survived long enough to receive this treatment and those that had suffered such an injury often also suffered life-threatening injuries to other body systems. Therefore treatment of the cervical spine was minimal while other injuries were treated.

Treatment of cervical injury is not only important in terms of initial trauma, but also as a means of minimising injury during subsequent treatment and thereby preventing potentially lethal damage occurring at a later stage among patients who survive. The Consultative Committee on Road Traffic Fatalities in Victoria produced the most comprehensive analysis of data on this topic (McDermott, Cordner et al. 2000). Between 1992 and 1994 they studied the pre-hospital and hospital treatment of 257 cases of cervical injury due to road trauma. Their observations, however, were limited by access to only standard autopsy reports rather than specific dissection. The results revealed the primary area of concern were errors in treatment decisions, especially in the emergency departments. This study also focused on prehospital and hospital care of the cervical spine (post crash factors), but also touched on aspects that contribute to the injuries (crash factors).

Prehospital

In a prehospital setting it is not always possible to determine whether a patient has a spinal injury. Due to complexities of cervical spine trauma and the devastating results that often ensue, emergency trauma organisations have instituted strict protocols when dealing with these patients. These protocols are constantly being reviewed and modifications implemented, however the contemporaneous guidelines associated with this study are not significantly different to those used in the most recent Ambulance Victoria Guidelines (Ambulance Officers' Training Centre 1991; Ambulance Victoria 2009). These guidelines highlight a conservative treatment with statements such as “if any doubt exists as to history or …assessment…then spinal immobilisation must be provided” (Ambulance Victoria 2009). This is further supported by appropriate triage of patients to the highest level of hospital care (Ministerial Taskforce on Trauma and Emergency Services and The Department of Human Services Working Party on Emergency and Trauma Services 1999). Indeed although previous studies have identified deficiencies in the treatment of road trauma cases, there have been limited concerns relating to prehospital management and this has primarily focused on airway issues (McDermott, Cordner et al. 2000; Ryan, Stella et al. 2004). A review by the Ambulance Association of Victoria in 1990 critically assessed equipment and protocols in relation to a number of treatment scenarios, including cervical spine injury. The major findings of this review were that the existing cervical collar urgently needed to be redesigned and that recognition of spinal injuries by paramedics at scene could reduce existing injury or prevent significant further damage. As a result, at the beginning of 1991 a new cervical collar – the Vertebrace – was introduced. This device is effective in reducing cervical movement and continues to be the exclusive neck support used by the Victorian Ambulance Association (Jerald, Solot et al. 1990). In conjunction with the development of the Vertebrace a summary of indicators for spinal injury was formulated (Appendix B).

In the analysis of treatment given by paramedics, the present study found that 88% of patients were supported using the Vertebrace or, in the case of children, rolled towels. The three cases that were not given this support included one where the neck was too fat to enable a brace to be fitted so rolled towels were used instead. In the remaining two cases the ambulance protocol and an initial assessment did not suggest any potential spinal injury and none was shown on dissection.

As the Vertebrace is a one piece rigid collar, it can only be used when both the head and neck are in the neutral position. This suggests a possible limitation in the application of this vital protective device but, in the limited scope of this study, no such issues with this restriction were evident. Many authors believe there is too great a reliance on cervical supports such as the Vertebrace (Ambulance Officers’ Training Centre 1991; Wilmink, Samra et al. 1996). Even the ambulance guidelines point out that effective use of the Vertebrace can only restrict 50% of movement at the head-neck complex, although this can be increased (to 80%) with the use of straps, and accessory padding. None of the cervical injuries in this study could be attributed to inappropriate treatment by paramedics. Not only did the Vertebrace provide some restriction of cervical movement it also acted as a warning to other health workers of possible cervical trauma. Other techniques, such as log rolling patients to prevent neck movements, may have reduced the possibility of further cervical injury. When dealing with motorcyclists there are further problems for paramedics regarding the removal of the helmet. Because helmets are made to fit the head tightly, there is the possibility of damaging the cervical spine when they are removed. Therefore Ambulance Victoria provides clear training for the safe removal of motorcycle helmets.

Hospital

In-hopsital treatment is comparatively more complex as highlighted by an increased number of problems identified in previous studies (McDermott, Cordner et al. 2000; Ryan, Stella et al. 2004); consequently the possibility for cervical injury to be relegated to a lower priority is increased. However, unlike other sections of the study it is not possible to view cervical injury as an independent variable. Because these injuries normally occur in association with other major trauma (7% with head injury and 20% with chest injury (Adams 1992) treatment of the cervical injury may be delayed due to a more obvious life threatening situation in another organ system. Such a scenario cannot then be identified as an oversight by the health worker.

Radiological clearing of the cervical spine was used as an indicator of treatment in hospital; only 56% of patients in this study received cervical x-rays and 21% of these had films taken that did not adequately visualise the entire cervical column. Fourteen of the 25 patients did not have their cervical spine radiographically cleared to a satisfactory level. However according to McLain and Benson (1998) who speculate that approximately 30% of all cervical trauma is not recognised at the time the patient is admitted, this is not uncommon. The primary reason for damage being missed is the ineffective use and analysis of cervical x-rays. Grundy and Swain (1993) suggest that if a lateral view of the cervical spine does not show all vertebrae adequately then it should be repeated. None of the patients in the present study received follow-up x-rays (even when it was obvious that the initial films were inadequate). The same authors also note that a lateral view of the cervical spine is not appropriate to determine injuries such as fracture to the lateral mass and transverse processes of C1, and fracture of the lower transverse processes and pedicles of C2. These limitations do not however immediately suggest the use of CT or MRI imaging, procedures that are so much more expensive than standard radiographs. Only in cases where results are unclear or suggest an occult injury should a CT scan be used, especially when the upper cervical spine (which the CT scan is better able to visualise) is in question. This was the case with five subjects. A further three cases should have been x-rayed or had a CT scan but neither were performed.

The need for further imaging was not determined arbitrarily, but from actual requests in the medical records or ambulance reports. Although paramedics are not qualified to determine a fracture of the cervical spine, their training allows then to identify probable cases.

Demographic and pathological factors affecting cervical trauma

Anatomical and pathological differences dependent upon age and past health not only have a significant impact on the severity of cervical trauma, but can also impact upon the treatment. Although paediatric data from the present study was insufficient to warrant statistical analysis, it did not prevent these cases from contributing useful information to the study of paediatric cervical trauma. The increased ability to withstand forces of an accident due to greater skeletal plasticity suggests that paediatric cervical spinal injuries are rare (Stawicki, Holmes et al. 2009) although there may be insufficient data to make an unbiased conclusion. Paediatric cervical spine injury is further complicated due to the changing skeletal anatomy with maturation. The literature considers paediatric cases to be those involving children aged eight years or under – after this age cervical spine anatomy resembles that of an adult (Rachesky, Boyce et al. 1987; Orenstein, Klein et al. 1994).

One of the paediatric cases in this study (aged 18 months) did not suffer any damage to the cervical spine. The only other, aged 8 years, did sustain damage to the vertebral artery in the upper part of the spine. However as no focal site for the injury could be located and as there was also significant haemorrhage associated with massive head injuries it was unable to be determined whether the damage to the vertebral artery was due to cervical trauma or a consequence of the head injury.

At the other end of the spectrum was the disproportionate number of elderly patients sustaining cervical injury. Cervical spine injury is more common in women (60-70%)

(Gebhard, Donaldson et al. 1994) due to their comparatively weaker neck musculature, and in those suffering spondylosis, usually the elderly. Spondylosis is a term used to define degenerative changes which target intervertebral discs of the spine and is particularly common in the cervical and lumbar regions. Affected discs lose mass and become narrower resulting in the potential for adjacent vertebrae to rub against one another forming osteophytes. The spinal cord and nerve roots are susceptible to compression from these bony outgrowths. Spondylosis is common in older people and often occurs in conjunction with osteoarthritis. Spines affected with these disorders rarely show radiographic anomalies; instead narrowing is determined by measuring the width of the spinal canal and establishing the presence of anterior or posterior osteophytes (Regenbogen, Rogers et al. 1986). The spine is also weakened so that less force is required to cause damage, leading to more frequent injury.

Restraints and supports – good and bad

Restraints – seatbelts, child restraints and helmets – have repeatedly been seen to significantly decrease rates of death associated with road trauma (Pedsen, Scurfield et al. 2004). However, previous comment has been made regarding the link between some restraints and increased incidence of cervical injury; these are addressed below.

While it is generally considered that the use of seatbelts decreases the severity of trauma suffered by car occupants involved in road traffic trauma some research suggests a link between seatbelts and hyperextension injury exacerbating the forces transferred through the neck by restraint of the torso (Galasko, Murray et al. 1993). However, this hypothesis is not supported by Traynelis and Gold (1993) and if all supports (including head rests) are present and correctly used seatbelts significantly decrease fatal road trauma (Pedsen, Scurfield et al. 2004).

There have been reports concerning the relationship between motorcycle helmets (especially full face helmets) and cervical spine injury. The possibility of damaging the cervical spinal cord when removing a full-face helmet has also been documented (Sarkar, Peek et al. 1995). Recent studies have not supported these concerns, and with the application of appropriate management and training by Victorian paramedics in removing helmets, it is concluded that the use of helmets is beneficial in reducing all trauma, including fatalities (Wagle, Perkins et al. 1993; Sarkar, Peek et al. 1995).

Because Australia has mandatory wearing of seatbelts in all cars and use of helmets by motorcyclists the issue is not as pertinent as in some other countries which don’t have these laws. However, the small number of cases that identified individuals who were not using restraints as well as the postulated negative effects to the cervical spine caused by some restraints warrants discussion.

Only three subjects in this study failed to wear the appropriate protective devices for the vehicle they were travelling in (a fourth subject who did not receive treatment at a hospital also failed to wear a helmet, highlighting the increased risk of fatality.) One of these was an 18-month-old child who, although wearing a seat-belt, was not in an approved child restraint and as a consequence was ejected from the car leading to massive head injuries. This case reinforces the point that not only does a restraint need to be worn, but it must be properly applied and, in the case of children, other specially designed seats must also be used (Pedsen, Scurfield et al. 2004).

Alcohol and Speed

Alcohol and speed are accepted as playing significant roles in increasing the likelihood and severity of road trauma. In Victoria blood alcohol concentration is limited to 0.05g/100 mL for fully licensed divers; a concentration in excess of this is considered to increase the likelihood of a crash by 1.83 times. Only one individual exceeded this threshold and this showed no influence on the injury outcome (McLean and Holubowycz 1981).

The impact of speed in the current study also provided minimal data; primarily due to the majority of cases (76%) classified at >60 km/h. Actual speed, irrespective of road design or speed limit, will produce similar injuries and therefore broad classification did not impede the current study. It may be more useful in future work related to road design and speed limitation to classify speed in relation to designated speed zones and thereby gain an insight into control or appropriateness of speed as opposed to an un-contextualised speed.

Conclusion and future work

Many of the commonly held risk factors for road traffic trauma such as youth, male gender and alcohol were not clearly highlighted in the current study. The most probable reason for this was the small sample size; when it was possible to examine the population, a more recognisable distribution was seen.

This study did highlight, however, the appropriate prehospital treatment received by all individuals. The study was confined to metropolitan Melbourne and with increased travel times, both to initially access patients and subsequent transport to hospital, it is conceivable that prehospital issues may arise if the study was conducted in a rural setting. Protocols and equipment remain the same, access to support and time to appropriate triage may be impacted. An assessment of the role and management by first responders (non-ambulance personnel) may also be warranted.

Finally, one of the major limitations of the present study was that all data regarding the crash site was provided second-hand and not for the specific purpose of this study; details such as speed of crash sometimes had to be collected or inferred from multiple sources. Future work would benefit from personal attendance at the scene to determine circumstances of the crash. Even if this only occurred in a small number of cases, the accuracy of the second-hand data might then be gauged. While there are obvious limitations with such a suggestion (and a specifically designed questionnaire may be more suitable) this approach would potentially increase the accuracy of data collection.

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Appendices

Appendix A: Age, gender and road user characteristic of each subject in the sample

**Those subjects who had spines removed but did not fit the study criteria

Age	**Gender**	**Road User**
25**	male	Motorcyclist
92	male	Pedestrian
79	male	Pedestrian
89	female	car – occupant
23**	male	car – occupant
89	male	car – occupant
18 months	female	car – ejected
74**	male	Motorcyclist
17	male	car - occupant
18	female	car – occupant
61	female	Pedestrian
30	male	Bicyclist
10	male	Bicyclist
52	male	Motorcyclist
16	male	Motorcyclist
38	female	car – occupant
78	male	Pedestrian
75	male	Pedestrian
83	male	car – occupant
81	male	car – occupant
25	female	car – occupant
72	male	car – occupant
60	female	car – occupant
8	male	car – occupant
46	female	pedestrian
72	male	pedestrian
38	male	motorcyclist
39	female	car - occupant

Appendix A

Indicators of cervical trauma for use by Victorian Ambulance Officers

Situations where:

- the mechanism of injury has involved high, especially uncontrolled, energy of impact of force, ie any history of sudden violent acceleration/deceleration collision forces which may have bent the spine in any direction
- the person has become a projectile. For example:
  - MCA greater than 75 kph
  - Pedestrian hit by car at greater than 30 kph
  - MCA involving a roll-over, ejection, etc

Other indicators may include:

- Falls in the elderly
- Significant trauma where unable to obtain history
- Any unconscious trauma patient
- Significant head injury eg with altered consciousness, transient loss of consciousness
- Helmet damage in a motorcycle accident
- Significant blunt trauma above the clavicles
- Significant blunt trauma to the torso
- Physical signs associated with the spine eg position
- Penetrating injuries to the region of the spine
- Musculo-skeletal symptoms and signs associated with the spine eg pain or tenderness