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Destination healthcare facility of patients with suspected traumatic brain injury in Scotland: Analysis of pre-hospital data

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ABSTRACT

Background: Traumatic brain injury is common. Guidelines from the Brain Trauma Foundation and the Scottish Intercollegiate Guidelines Network recommend that patients with suspected severe traumatic brain injury should be treated in centres with neurosurgical expertise. Scotland does not have a framework for the delivery of trauma care. The aim of this study was to examine the demographic characteristics of incidents involving patients who have suffered a suspected traumatic brain injury, and to evaluate the level of the destination healthcare facility which patients are currently taken to.

Methods: Retrospective analysis of prospectively collected Scottish Ambulance Service data on incidents involving traumatic injury, between Nov 2008 and Oct 2010. Two groups of casualties were analysed: those who had a Glasgow coma scale of less than 14 (GCS < 14), and those who had a Glasgow coma scale of less than 9 (GCS < 9).

Results: 126,934 incidents were identified and analysed. 3890 (3.1%) patients had a GCS of less than 14, and 657 (0.5% of total) had a GCS of less than 9. Almost one-third of incidents involving patients with either a GCS < 14 or GCS < 9 occurred in the greater Glasgow health board area. The Lothian health board region had the second-highest number of patients with either a GCS < 14 or GCS < 9. Only 13.8% of patients with a GCS < 14, and 16.7% of those with a GCS < 9, were taken to a hospital with a neurosurgical service.

Conclusions: Many patients who may harbour a traumatic brain injury are taken to a facility which may not be equipped or staffed to deal with such injuries. This mismatch needs to be addressed. However, the care of patients with head injuries is only one aspect of trauma care. The UK has long lagged behind North America in terms of the quality of trauma care provided, although the provision of trauma care in England is currently undergoing major changes. Scotland should consider the development of a similar service delivery framework.

Introduction

Trauma remains a leading cause of death and disability in patients under 40, and traumatic brain injury is a major contributor to adverse outcome.[1,2] "Head injuries" account for approximately 100,000 emergency department attendances in Scotland per year.[3] Mortality and morbidity, including long-term disability, are minimised by appropriate initial management and prompt definitive treatment. Secondary brain injury is an evolving process, which develops in the minutes and hours following the initial injury, and can be mitigated against by early, specialist care.[1] Hypotension and hypoxaemia in particular are known to be associated with poor outcomes following head injury.[1,3,4] Current guidelines from the Brain Trauma Foundation and the Scottish Intercollegiate Guidelines Network recommend that patients with suspected traumatic brain injury should be treated in centres with neurosurgical expertise.[1,3] Pre-hospital triage protocols from the United States reflect this guidance, by directing patients with a Glasgow Coma Scale of less than 14 to the highest level trauma centre available.[5] Such centres almost invariably have a neurosurgical service,[6] facilitating timely intervention, if required. Guidelines from the Royal College of Surgeons of England also recommend that patients requiring decompressive surgery for traumatic brain injury should be treated within 4 h.[7] Direct admission to a centre with appropriate facilities and capabilities

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Table 1
Baseline characteristics.

		GCS < 14	GCS < 9
Number of incidents		3890	657
Gender	Male, *n* (%)	2303 (59.2)	466 (70.9)
	Female, *n* (%)	1399 (36.0)	144 (21.9)
	No gender recorded, *n* (%)	188 (4.8)	47 (7.2)
Age (yrs)	Median (interquartile range)	46 (24–71)	32 (19–55)
Physiological derangement	Systolic blood pressure <90 mmHg, *n* (%)	218 (5.6)	52 (7.9)
	SpO_2 < 90%, *n* (%)	116 (3.0)	33 (5.0)

limits the need for secondary (interhospital) transfers, which have been shown to take, on average, 6 h in the UK.[8]

Scotland does not have a framework for the delivery of trauma care.[9] The aim of this study was to examine the demographic characteristics of incidents involving patients who suffer a suspected traumatic brain injury, and to evaluate the level of the destination healthcare facility which patients are currently taken to.

Patients and methods

This is a retrospective analysis of data routinely collected by the Scottish Ambulance Service (SAS). The Scottish Ambulance Service maintains an electronic patient record system, which contains information on incident location, patient demographics, vital signs, despatch determinants, travel times and destination hospitals. These data are recorded prospectively, by despatchers and ambulance crews. The MPDS (Medical Priority Despatch System) determinant code is an important part of the record. It is initially generated by a caller interrogation system (Medical Priority Despatch System, Priority Dispatch Corp.™, Salt Lake City, Utah), and subsequently modified, to accurately reflect diagnoses. The first component of the code refers to the protocol (or "card") and indicates a broad category of emergency.

We used the final MPDS code to extract data pertaining to incidents recorded as assaults (protocol 04), falls (protocol 17), penetrating injuries (protocol 27), traffic and transportation injuries (protocol 29), and other traumatic injuries (protocol 30) attended to by the ambulance service between 1 Nov 2008 and 31 Oct 2010. Patients without a recorded Glasgow coma scale (GCS), children under the age of 14, and those undergoing secondary transfers were also excluded. Extracted data included demographics, incident location, GCS, systolic blood pressure, oxygen saturation and final destination hospital. Incidents without location postcodes were excluded. Missing values were treated as missing, and not included in any subsequent analysis. The level of the destination facility was coded using the Scottish Government classification, as teaching hospital, large general hospital, general hospital, community hospital, or other facility. Teaching hospitals were further divided into those with a neurosurgical service (Western General Hospital, Edinburgh; Southern General Hospital, Glasgow; Ninewells Hospital, Dundee; Aberdeen Royal Infirmary, Aberdeen). Incident locations were coded by health board regions.

Two groups of patients were analysed: Patients who had a Glasgow coma scale of less than 14 (GCS < 14), representing casualties who would have been triaged to the highest level trauma centre in a North American trauma system (in most cases, a level 1 trauma centre with a neurosurgical service). We also analysed casualties who had a Glasgow coma scale of less than 9 (GCS < 9), representing a subgroup of patients with more severe injury, and an even greater likelihood of requiring specialist neurosurgical and neurocritical care.

The analysis was performed using Microsoft Excel™ (Microsoft®, Redmond, WA, USA).

Results

126,934 incidents met the inclusion criteria and were extracted. 3890 (3.1%) patients had a Glasgow coma scale of less than 14, of which 657 (0.5% of total) had a Glasgow coma scale of less than 9. The baseline characteristics of the two groups are shown in Table 1. The median age of patients in the GCS < 14 group was 46, and 32 in the GCS < 9 group. 5.6% of patients with a GCS < 14 and 7.9% of patients with a GCS < 9 had a least one episode of hypotension (defined as a systolic blood pressure of <90 mmHg) during transport, and 3.0% of patients with a GCS < 14 and 5.0% of patients with a GCS < 9 had at least one episode of desaturation (defined as SpO_2 < 90%). The distribution of Glasgow coma scale scores is shown in Fig. 1.

The geographical distribution of the incidents is shown in Fig. 2. Almost one-third of incidents involving patients with either a GCS < 14 or GCS < 9 occurred in the greater Glasgow health board area. The Lothian health board region had the second-highest number of patients with either a GCS < 14 or GCS < 9.

The destination facility level of patients with a GCS < 14 is shown in Fig. 3, and those with a GCS < 9 in Fig. 4. Only 13.8% of patients with a GCS < 14, and 16.7% of those with a GCS < 9, were taken to a hospital with a neurosurgical service. 86.2% of patients with a GCS < 14 were taken to a hospital without a neurosurgical service, including 1.6% who were taken to a community hospital. In the more severely injured group (GCS < 9), 82.9% were taken to a hospital without a neurosurgical service, including 2.7% who were taken to a community hospital.

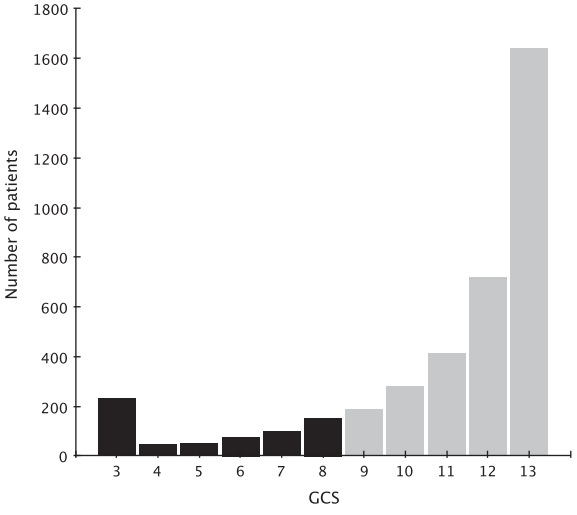

Fig. 1. Distribution of Glasgow coma scale scores (dark grey, GCS < 9 subgroup).

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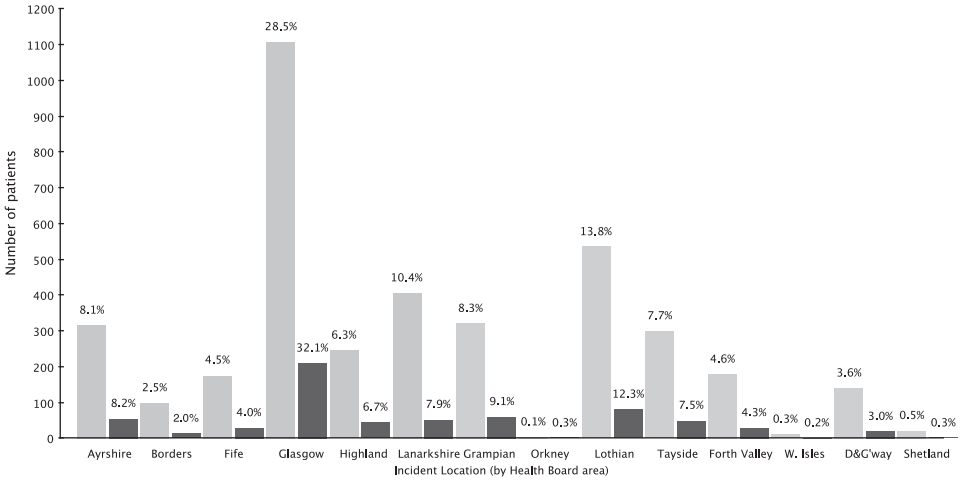

Fig. 2. Incident location distribution (light grey, GCS < 14; dark grey, GCS < 9).

Discussion

This study shows that fewer than one in five patients who may harbour a traumatic brain injury are taken to a hospital with neurosurgical capability. Approximately one-third of such incidents are clustered in the Greater Glasgow and Clyde health board area, and more than half occurred in the health board areas which contain the four Scottish neurosurgical centres.

The National Trauma Triage Protocol is a validated and accepted instrument for selecting patients requiring high-level trauma care, and the de facto standard of care for pre-hospital triage. It recommends that patients with a GCS < 14 should be "transported preferentially to the highest level of care within the trauma system".[5] Scotland does not have a trauma system, or designated trauma centres, and no pre-hospital triage. Patients with traumatic injuries are taken to the nearest hospital with an emergency department, irrespective of the patient's injuries, or the capabilities of the centre which the patient is taken to.[9] Our results show that 86.2% of Scottish casualties with a GCS < 14, who would have triggered transport to a trauma centre – with, in all likelihood, neurosurgical capability – in the United States, are taken to a hospital which does not have the facilities or staff to deal with such injuries. This is concerning. Even if a lower GCS (<9) is chosen as the cut-off – indicating a higher likelihood of traumatic brain injury, and need for specialist care – only 16.7% of patients are taken to a centre with neurosurgical capability. Again, this is concerning, and furthermore shows that there is no surreptitious triage, i.e. ambulance crews taking casualties to a hospital other than the nearest facility, on account of the severity of their injuries, or their perception of hospitals' capabilities.

Clearly, not all patients with a decreased level of consciousness have a traumatic brain injury. Furthermore, of those patients who do, not all require neurosurgical intervention. However, this argument is unhelpful, because pre-hospital care providers do not have this information, and because patients who have suffered a traumatic brain injury, yet do not require an operation, may still benefit from specialist care. Specialist care comprises expert neurocritical care, and the advice and ready availability of a neurosurgeon. Whilst some would argue that specialist neurocritical care can be provided without a neurosurgical service, common sense dictates that these services are best co-located.

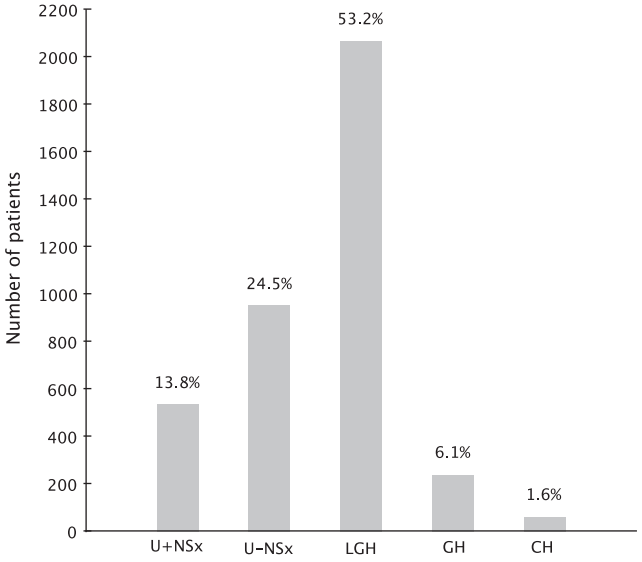

Fig. 3. Level of destination facility of patients with a GCS < 14 (U+NSx, university hospital with neurosurgical service; U-NSx, university hospital without neurosurgical service; LGH, large general hospital; GH, general hospital; CH, community hospital).

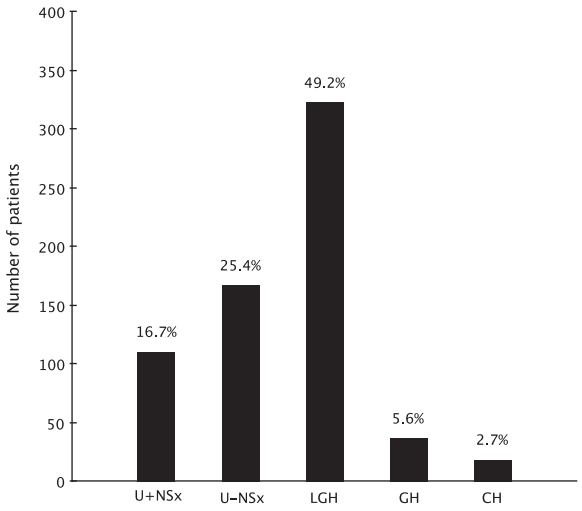

Fig. 4. Level of destination facility of patients with GCS < 9 (U+NSx, university hospital with neurosurgical service; U−NSx, university hospital without neurosurgical service; LGH, large general hospital; GH, general hospital; CH, community hospital).

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The implications of our findings are that many patients in Scotland receive a lesser standard of care than would be provided elsewhere in the world; or that a substantial number of patients in Scotland require secondary transfer, to a neurosurgical centre. This study cannot answer if the latter is the case, as secondary transfers are undertaken by more than one service, and data are therefore incomplete. Even if many patients are transferred, secondarily, to an appropriate facility, one would have to question whether immediate transport to such a centre would not be advantageous, and avoid the delays and dangers inherent in transferring brain-injured patients between hospitals.

This study has other limitations, the most important being the use of the MPDS codes to select patients who have suffered trauma. It is possible that, on further investigation, some of the patients who were initially thought to have a traumatic brain injury had actually suffered a non-traumatic neurological insult. It is also possible that some of the initial despatch codes may not have been updated. For example, a patient attended to on account of a suspected fall (and therefore trauma) may actually have suffered a collapse, due to non-traumatic causes. Whilst the former represents appropriate clinical decision making, based on available information, the latter is a coding error, which would result in over-estimation of the number of trauma patients, and the number of patients with suspected traumatic brain injury. Detecting the magnitude of this error is difficult, and would require either a prospective study, or a large-scale validation against hospital records.

"Missing data" is a further issue. The data used for this study were obtained from an electronic patient record system, which was not designed for audit or research. Not all patients had their ages or even gender recorded. The recording of vital signs may be similarly inconsistent. The absence of a recorded blood pressure may be due to a clinical assessment, perhaps indicating that there was no need to do so, or because it could not be measured, because it was so low. The magnitude, and even direction, of this effect is difficult to judge. Furthermore, the distribution of the GCS scores recorded shows a bimodal pattern, with a relatively high number of "GCS 3's". This may be an indication of patients with a profoundly depressed level of consciousness simply labelled as "GCS 3", rather than the scores being calculated accurately.

This study does not include patients who were not taken to an emergency department by the ambulance service, although the number of patients with traumatic brain injuries who present in this way is probably small. Lastly, this study contains no information on outcome. It would be useful to know whether patients who would have been triaged to high-level trauma centre care, but were admitted to a hospital without neurosurgical service, suffered worse mortality, or more disability, than those who were taken to a centre with a neurosurgical service. Obtaining such information would require a prospective design, or linkage to other databases.

Despite these limitations, this study adds to our understanding of trauma care in Scotland. The current mismatch between patients' needs and their treatment could be addressed through pre-hospital triage, using existing instruments, and primary transfer to a centre with neurosurgical capability, directly from the scene. The geographical distribution of the incidents – around major urban conurbations, and particularly Glasgow – would appear to facilitate such a strategy.

Conclusion

It appears that many patients who may harbour a traumatic brain injury are taken to a facility which may not be equipped or staffed to deal with such injuries. This mismatch needs to be addressed. However, the care of patients with head injuries is only one aspect of trauma care. The effectiveness of a trauma system – comprising pre-hospital care, designated trauma centres, inter-hospital transfer arrangements, rehabilitation and clinical governance – in reducing death and disability is well established.[10–12] Changes to the provision of care for patients with suspected traumatic brain injury should form part of a wider reorganisation of trauma care. The UK has long lagged behind North America in terms of the quality of trauma care provided.[13–16] Recognition of the poor quality of existing services in England has precipitated a paradigm shift in healthcare policy, resulting in the commissioning of a network of regional trauma systems[17]. Scotland should consider developing similar services.

Conflict of interest statement

The authors are not aware of any financial and personal relationships with other people or organisations that could inappropriately influence (bias) this work.

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