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Have ATLS and national transfer guidelines improved the quality of resuscitation and transfer of head-injured patients? A prospective survey from a Regional Neurosurgical Unit

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Abstract

High-quality resuscitation and care during transfer of head-injured patients is essential to prevent secondary brain injury. We have prospectively assessed the standard of resuscitation in 50 consecutive head-injured patients transferred to our unit, and compared our findings with previous studies performed before the advanced trauma life support course (ATLS) had become widespread and national guidelines on the transfer of head injuries had been produced by the Association of Anaesthetists of Great Britain and Ireland (AAGBI). Delays in transfer, management of the airway, adequate cervical spine assessment, hypoxia (P_aO_2 <13 kPa), hypotension (systolic BP <90 mmHg), missed injuries and the experience of the medical escort were compared against the standards laid out in ATLS and AAGBI Guidelines.

The mean, unavoidable delay from arrival at the local accident and emergency unit to arrival was 7.4 ± 1.9 h (mean ± 95%CI) with most of the delay being prior to initial referral. Two patients arrived with an unsecured airway with a GCS = 8/15; 26 had inadequate cervical spine imaging; 7 patients arrived hypoxic and 2 patients arrived hypotensive; most of these insults occurred during the transfer. Forty-six percent of medical escorts did not fulfil the minimum standard of experience.

ATLS and AAGBI guidelines have provided only modest improvements in patient care at the expense of long delays in transfer. The incidence of hypoxia and hypotension remains unacceptably high.

1. Introduction

Trauma is the commonest cause of death in people <45 years old. Head injuries are the cause of approximately half of all trauma deaths and account for most of the disability in the survivors [13]. It is well appreciated that secondary insults to the injured brain result in a worse outcome [4,9,10,18]. Even a single episode of hypotension can double mortality and increase morbidity [5]. Transporting head-injured patients, even short distances within the same hospital, is associated with a high incidence of secondary insults, especially in unstable patients who have not been properly resuscitated [3]. As neurosurgical care is organised in regional centres, interhospital transfer of these patients is common practice.

A number of previous studies looked at the quality of resuscitation and transfer of head-injured patients and found major problems [6,8–10,12,15,16,18,25] (summarised in Table 1). All these studies, however, were either published or report the results of patients transferred before December 1993. Since this date there have been two major factors that should have an impact on the quality of resuscitation and transfer of head-injured patients. The first is the wider uptake of Advanced Trauma Life Support (ATLS) courses, the second is the publication "recommendations for the transfer of patients with acute head injuries to neurosurgical units" by the Association of Anaesthetists of Great Britain and Ireland (AAGBI) in December 1996 [2]. The latter document provides guidelines on the standards of care for monitoring, escorts and organisation for transferring head-injured patients.

The Essex Centre for Neuroscience in Oldchurch Hospital, Romford, is a regional neurosurgical unit (RNSU) covering a population of 2 million in Essex, East Hertfordshire and parts of East London. All referring hospitals have been sent local transfer guidelines. These stress the importance

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Table 1
The standards used

	Standard	Source
Delays	All patients requiring emergency surgery <4 h from arrival in A&E to arrival at RNSU Unstable patients suitably stabilised before transfer	ATLS
Cervical spine	Cervical spine immobilised with hard collar Lateral c-spine X-ray demonstrating C1 to top of T1 (supplemented with CT or further plain views)	ATLS
Intubation	Immediately Coma (i.e. GCS ≤8) Loss of Protective Airway Reflexes Ventilatory insufficiency (i.e. *hypoxia* PaO_2 <9 kPa on air or <13 kPa on oxygen, *hypercarbia* $PaCO_2$ >6 kPa) Spontaneous hyperventilation causing $PaCO_2$ <3.5 kPa Respiratory arrythmia Prior to transfer Significant deterioration of conscious level Bilateral mandibular fractures Copious bleeding into the mouth Seizures	AAGBI
Hypoxia and hypotension	Hypoxic if PaO_2 <13 kPa on oxygen Hypotensive if systolic blood pressure <90 mmHg and/or heart rate >100/min Systolic blood pressure should be maintained above 120 mmHg	AAGBI and ATLS
Missed injuries	No significant injury missed Extracranial injuries adequately splinted	ATLS
Escort	Minimum experience of 2 years training in anaesthesia Monitoring during transit to include ECG, invasive blood pressure, pulse oximetry and end-tidal CO_2 measurements.	AAGBI

of airway protection, adequate resuscitation (including suturing large scalp wounds), stabilisation and imaging of cervical spine and the immobilisation of long bone fractures. In addition, members of the consultant staff regularly teach the new accident and emergency staff in the local hospitals.

Our aim was to study the quality of resuscitation and transfer in patients transferred to our unit, and compare our results with earlier studies to assess the impact of ATLS and AAGBI.

2. Patients and methods

Information was collected on 50 consecutive head-injured patients transferred to our unit. Patients admitted via the Oldchurch Accident and Emergency Unit and patients transferred for other reasons (two patients primarily transferred for management of spinal injuries) were excluded. Information was gathered from the medical notes, transfer documentation, the medical escort and the admitting nursing and medical staff, and was recorded within 24 h of admission on a standardised proforma. If required, information was supplemented with a phone call to the referring team. Cervical spine X-rays from the referring hospital were studied to ensure they showed C1 to the C7/T1 junction. In addition, the medical escort was asked to complete a questionnaire outlining their experience and involvement with the patients' resuscitation and monitoring used during transfer.

The standards of resuscitation and transfer used in this study were taken from either the ATLS reference manual or the AAGBI recommendations. They are summarised in Tables 1 and 2. The delay in transfer was calculated from the time of admission to the referring accident and emergency department (A&E) to the time of arrival at the RNSU. In the majority of cases, the time of the initial referral to the on call neurosurgical specialist registrar could be determined from cards completed at the time of a referral.

Delays were presented as the mean number of hours delay ±95% confidence intervals.

3. Results

3.1. Demographics of study population

The mean age of the patients transferred was 42.1 years (11–80) and there were 41 males and 9 females. Twenty-one patients had been involved in a motor vehicle crash, 15 had fallen, 9 had been assaulted and 5 had been injured in sporting or work-related incidents.

3.2. Delay in transfer

Information on the time of admission to the referring A&E Department and subsequent admission to the RNSU was available in 49 of the 50 cases. The delay from arrival in

Table 2
Review of previous papers studying quality of assessment and resuscitation of head-injured patients

Study	Study period	*n*	Hypoxia	Hypotension	Missed injuries[a]
Miller (1978) [18]	–	100	30 (30%) PaO_2 <8.7 kPa	13 (13%) sBP[b] <95 mmHg	–
Gentleman (1981) [9]	August 1979–July 1980	150	34 (23%) PaO_2 <8 kPa	17 (11%) sBP <90 mmHg	21 (14%)
Gentleman (1990) [10]	June 1986–December 1987	200	25 (15%) PaO_2 <9.3 kPa	14 (7%)[c]	20 (10%)
Lambert (1993) [15]	August 1989–July 1990	21	–	–	7 (33%)
Hicks (1994) [12]	June 1991–May 1992	154	10 (9.7%) PaO_2 <10 kPa	11 (7.1%) sBP <90 mmHg; 16 (10.4%) sBP <120 mmHg with tachycardia	7 (5%)
Dunn (1997) [6]	November 1992–December 1993	50	3 (6%) SaO_2 <95%	15% sBP <90 mmHg	5 (10%)
Our series	May 1999–December 2000	50	6 (12%) PaO_2 <13 kPa on O_2	2 (4%) sBP <90 mmHg	3 (6%) Serious injuries

[a] Includes injuries that were inadequately treated.
[b] sBP: systolic blood pressure.
[c] Definition not given.

A&E to admission to the RNSU was 10.1 ± 3.5 h. This delay included three patients who were admitted with 'minor head injuries' and later deteriorated, and two patients who were too unstable for immediate transfer. If we exclude these patients the mean delay was 7.4 ± 1.9 h.

In 33 cases, the time the RNSU was first contacted was available from the referral cards completed by the neurosurgical specialist registrar. The delay from A&E to RNSU in this group was 6.8 ± 1.3 h. The delay from arrival at the referring hospital to initial contact with the RNSU was 3.7 ± 1.1 h and the delay from initial referral to arrival at the RNSU was 3.2 ± 0.8 h.

Seventeen patients required urgent surgical intervention following transfer (14 acute subdural haematomas, 5 extradural haematomas and 1 temporal lobe contusion). In this group of patients, the total delay from A&E to RNSU was 7.0 ± 2.2 h, with a delay of 4.0 ± 1.8 h from arrival in A&E to initial neurosurgical referral and a delay of 3.0 ± 0.9 h from initial referral to arrival at the RNSU.

In 16 patients, the cause for delay could be identified. These included the seven patients transferred from hospitals outside the Oldchurch catchment area. In all these cases, delays were caused by the difficulty in finding a neurosurgical intensive care bed. The mean delay for these patients was 7.7 ± 1.6 h. This does not differ greatly from those referred from within the Oldchurch region where the mean delay was 7.6 ± 2.5 h. For these out of region patients the delay from arrival in A&E to initial referral was 5.4 ± 2.3 h and the delay from referral to arrival in the RNRU was 2.8 ± 2.0 h. In three cases, there appeared to be a delay in obtaining a CT scan out of hours. In all the cases, there was difficulty contacting the duty consultant radiologist to authorise the CT. In a further three cases there were difficulties obtaining an ambulance for transport. In a further three cases, there was an apparent lack of appreciation of the severity of the injury. In all these cases, the patients were admitted as 'minor isolated head injuries' with GCS between 10 and 13 and observed overnight. In all these cases, the patient was only seen by a junior surgical trainee. The severity was appreciated by more senior colleagues in the morning.

3.3. *Cervical spine management*

Adequate cervical immobilisation was performed in 33/50 patients. In the 17 patients, where immobilisation was inadequate, the commonest reason was removal of collar before adequate imaging was obtained.

Only 24 out of 50 patients had adequate imaging demonstrating C1 down to the top of T1. The commonest reason for inadequate imaging was the failure to demonstrate the C7/T1 junction.

3.4. *Airway control*

Thirty-five patients were admitted intubated and ventilated. Two patients who had an indication for early or late intubation were transferred without secure airway control. In one patient, the ET tube was accidentally dislodged on transfer onto the ITU bed, because the endotracheal tube was inadequate secured.

3.5. *Hypoxia and hypotension*

Seven patients were hypoxic on admission. One patient was hypoxic before transfer; the other six became hypoxic during transfer. Ten patients had systolic pressures below 120 mmHg on admission to the RNSU with two arriving hypotensive with systolic pressures below 90 mmHg. Both of these patients were transferred before their hypotension was corrected. One of these patients was both hypoxic and hypotensive on admission. In addition, three patients arrived hypertensive with a systolic blood pressure >210 mmHg.

3.6. *Missed or inadequately managed injuries*

In total, 13 patients had missed or inadequately treated injuries of which three were serious. In two patients, serious chest injuries were missed. One patient had multiple rib fractures with an underlying pneumothorax; the other had a large flail segment with a pulmonary contusion. Both patients arrived hypotensive; the latter was also hypoxic. Three patients had other minor injuries that were missed, a distal radial fracture, fracture through the radial neck and a grade III acromioclavicular dissociation that was only identified 8 days following injury.

Fourteen patients had associated scalp lacerations. Only half were sutured before transfer. This included a man with a 35 cm laceration that was not sutured. He arrived needing a blood transfusion to replace his losses.

3.7. Medical escorts

In 42 cases (84%), the patient was accompanied by an anaesthetist. One patient arrived unintubated with a GCS of six without a medical escort. He became hypoxic on transfer.

A questionnaire was completed by the escorting doctor in 26 cases. The escorting doctor was only involved in the initial management of 10 cases. Only five had been involved in more than five transfers in the last year. Twelve of the escorts failed to meet the requirements of the AAGBI in terms of experience.

During transfer all patients had ECG and oximetry monitoring. Eighteen escorts used arterial lines for blood pressure monitoring, and only five used end-tidal CO_2 monitoring.

4. Discussion

Although the ATLS course was introduced into the UK in November 1988, it has been over the last 6 years that the course has become more widespread with double the number of courses. From 1988 to 1994 there were 4738 candidates. From 1994 to 1999 there were a further 14,889 candidates (Natalie Brule, Royal College of Surgeons of England, September 2000, personal communication).

In our study, we found there was an excessive delay in transferring a patient to the RNSU with a mean delay of 7.4 ± 1.9 h. Previous studies found that the mean unavoidable delay in transfer was 3.4 h [12] to 4.0 h [6]. In three cohorts of head-injured patients studied in Glasgow, the numbers of patients transferred within 6 h of injury improved over a 10-year period [8–10]. We are unsure why it takes so long to transfer patients to our unit although Vyvyan has suggested a number of reasons for delay [25]. We found the main delay was before initial contact with the neurosurgeons, a finding previously described by Marsh et al. [16]. The group of patients where this delay is of greatest concern is those requiring urgent neurosurgical intervention. We found the delay in this group was 7.0 ± 2.2 h. Delay in the evacuation of extradural [17,20] and subdural haematomas [22] is associated with a poorer prognosis.

In a number of patients we could identify the cause of the delay. Lack of a neurosurgical ITU bed is a common problem. In this group of patients, the delay was not that different from those within the Oldchurch region. The reasons for this are not clear, the delay after the initial referral was not significantly shorter (2.8 ± 2.0 h versus 3.2 ± 0.8 h). Other causes for delay included difficulty in obtaining out of hours CT imaging. In many of these units, the problem appeared to be caused by delays in contacting the duty radiologist to authorise a CT. The report from the Royal College of Surgeons of England Working Party on the Management of Patients with Head Injuries [1] emphasises that all hospitals receiving patients with head injuries must be able to perform on-site CT scans 24 h a day. It also stresses that "CT scanning of the head at the referring unit must not be allowed to delay any necessary patient transfer" [1].

The radiological assessment of cervical spine injuries was inadequate in more than half the cases. The commonest problem was failure to identify the C7/T1 junction, potentially missing 9% of cervical injuries [19]. Although our standard for neck imaging will only identify 85% of cervical spine injuries [23], it is the standard practice in excluding cervical spine injuries in unconscious patients in the UK. With these criteria, satisfactory immobilisation only occurred in 66% of patients. Better assessment of cervical spine injuries could be obtained by CT imaging of the C1/2 region and C7/8 if not seen. The time added using the modern generation of CT scanners would be minimal.

Previous studies had identified failure of early airway control to be a major cause of hypoxia [9,10,18]. In our study, the incidence of poor airway control had improved with only two patients transferred without intubation. We still had seven patients developing hypoxia during the transfer.

Ten patients arrived with systolic pressures <120 mmHg. The three patients with the lowest systolic blood pressure were all inadequately resuscitated. The other patients had no obvious cause for their hypotension; this was believed to be due to injudicious use of sedating anaesthetic agents (usually intravenous propofol). Two patients were hypotensive on admission. Both of these patients had major chest injuries that were missed at the referring hospital. Although the rate of significant hypotension has improved from previous studies, further improvement is still needed. Hypertension should similarly be avoided following brain injury since this can cause disruption of autoregulation and the blood–brain barrier promoting brain swelling [24].

The previously high incidence of missed or inadequately treated injuries has also decreased in our study. Grant and Shrouder found a similar improvement with only nine missed injuries in 115 patients transferred from an A&E department to a neurosurgical unit [11]. Better identification of these injuries is likely to be due to the ATLS approach to a trauma patient; we found evidence of a secondary survey having been carried out in all our patients. In our series, only three serious injuries were inadequately managed, including two chest injuries and one large laceration of the scalp not sutured for haemostasis. The importance of suturing scalp wounds to obtain haemostasis prior to transfer has been previously described by Fitzpatrick and Goyal [7]. ATLS however teaches that generally scalp lacerations do not cause haemorrhage sufficient to cause haemodynamic instability and as a result, haemostatic sutures are not considered in these patients.

We had a 62% response rate from the questionnaires given to the medical escort. Interestingly, questionnaires were not completed for patients with the highest incidence of problems during transfer. The medical escorts accompanying the patient to the RNSU were rarely involved in their resuscitation and were frequently too inexperienced. Previous studies have confirmed these findings and have shown that the majority of transfers are performed by senior house officers with <2 years of experience in anaesthesia [12,14,25]. Lack of experience may explain why most patients who arrive at the RNSU hypoxic or hypotensive appear to develop these during transfer. All the patients had pulse oximetry and ECG monitoring for the journey, only 70% had invasive blood pressure monitoring, the other 30% relied on non-invasive monitoring despite evidence that these are unreliable in transit [21]. The availability of end-tidal CO_2 remains low even though this is considered essential for patients undergoing general anaesthesia.

We feel that there have been some improvements in patient care since the introduction of ATLS and AAGBI guidelines but these appear to be at the expense of long transfer delays. The high incidence of poor airway management and missed or inadequately treated injuries appear to have improved but the incidence of hypoxia and hypotension remains unacceptably high. We suspect there are a number of causes for this. Firstly, the didactic teaching of ATLS, however, teaches by rote but does not encourage thought about why things are done. The emphasis on circulatory support, for example fails to stress the importance of maintaining adequate cerebral perfusion. Secondly, problems occur due to the lack of experience of staff resuscitating and transferring these patients. Most A&E departments are under resourced and often do not have senior, experienced staff available when head-injured patients are admitted. In particular, any improvement of care during transfer with require more experienced medical escorts and better access to portable monitoring will hopefully reduce the frequency of hypoxia and hypotension developing during transit.

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