An audit of trauma deaths occurring in the accident and emergency department

M. W. G. GORDON, C. LUKE, C. E. ROBERTSON & A. BUSUTTIL*

*Department of Accident and Emergency Medicine and Surgery, Royal Infirmary, and
*Forensic Medicine Unit, Department of Pathology, University of Edinburgh, Edinburgh,
Scotland.*

SUMMARY

A retrospective study of all patients who died following trauma in the Accident and Emergency Department of the royal Infirmary of Edinburgh over a 4-year period revealed 50 patients (0.0002% of total attendances). Injury severity scores (ISS) and probabilities of survival (Ps) were calculated for all patients. Two-thirds had a Ps of zero while 7 (14%) had a Ps of 0.5 or more. From the information in the case records and at autopsy four deaths (8%) were considered to have been potentially avoidable on the basis of inadequate or inappropriate management. There were a further eight cases (16%) whose management appeared to have been unsatisfactory but who would have been expected to die even if given optimal treatment. These cases are discussed in detail.

Difficulty in diagnosing thoracic injuries and delay in giving appropriate treatment were by far the commonest errors encountered. A protocol for the treatment of patients in cardiorespiratory arrest with thoracic injuries is presented. The importance of regular audit of trauma cases and deaths is emphasized.

INTRODUCTION

In Scotland, trauma is the commonest cause of death between the ages of 1 and 44 years, while between the ages of 5 and 34 years, accidents and violence produce more deaths than all other causes added together (Scottish Health Statistics 1986/87). In England and Wales accidents and violence cause more deaths than anything else in those aged 15–34 years and in males aged 1–14 years. For females aged 1–14 years accidents and violence come second only to congenital abnormalities (Department of Health and Social Security). There has recently been interest in relation to the adequacy of management of trauma both in and out of hospital but there is a paucity of objective

Correspondence: M. W. G. Gordon, Department of Accident and Emergency Medicine, Royal Infirmary, Lauriston Place, Edinburgh EH3 9YW, Scotland.

data with regard to the numbers and exact causes of death in patients sustaining major trauma in the UK. With this in mind, it is appropriate to consider whether such patients are dying needlessly in accident and emergency departments and if so, to elucidate the reasons involved.

METHODS

A retrospective study was performed of all patients who died in the Accident and Emergency Department of the Royal Infirmary of Edinburgh as a consequence of trauma during the 4-year period from 1 January 1982 to 31 December 1985. Patients who did not receive any hospital treatment, and in whom the certification of death on arrival was the sole medical involvement, were excluded. Those cases who were admitted to a ward as in-patients and later died under the care of another specialty were similarly excluded. During the study period 247164 new patients presented to this Accident and Emergency Department. Of these 50 (0.0002% of total attendances) died from traumatic causes within the department.

Data were obtained from the clinical records and from post-mortem examination reports carried out on the instructions of the Procurator Fiscal involved. This facilitated the accurate derivation of injury severity scores (ISS) for all the subjects, as described in the 1985 revision of the Abbreviated Injury Scale (AIS) Dictionary (The Abbreviated Injury Scale, 1985 Revision). An allowance for age was made by using the probability of mortality (Pm) table published by Bull and calculating probability of survival (Ps) using the equation $Pm + Ps = 1$ (Bull, 1978).

RESULTS

The 50 patients in our study had a mean age of 43 years (range 2–92 years) with median value of 41 years (Figure 1). As previously reported, there is a marked peak in

Fig. 1 Age distribution of traumatic deaths (1982–1985).

the 20–29-year age group Baker & Scottish Health Statistics, 1986/87) O'Neill, 1984, but there is a second peak in the sixth decade. Thirty-three (66%) of the deaths were in males.

The Accident and Emergency Department records include accurate times of arrival and of death of all the patients. Over three-quarters of the patients studied arrived outwith 'normal' working hours (Figure 2). This figure is even higher if weekends and public holidays are taken into account.

Road-traffic accidents accounted for over 60% of all deaths in the study, while assaults and falls from a height together contribute the majority of the remainder (Figure 3). As is typical of the pattern of trauma in the UK, there was only one patient who died following a gunshot wound, and this was self-inflicted.

Within the group of road-traffic accident deaths, those occurring in pedestrians outstripped those of all other groups by accounting for just over half of the road-traffic accident deaths and 40% of all the deaths studied.

Major trauma has been internationally defined as an ISS of greater than 15 (Boyd *et al.*, 1987). All the patients met this criteria since the lowest score in the study was 22 (Figure 4). Thirty-four per cent of the patients had the maximum ISS of 75.

The Ps revealed that two-thirds of the patients had a Ps of zero (Figure 5). However, 14% (7 patients) had a Ps of 0.5 or more. This prompted a closer examination of the case records and the post-mortem findings to ascertain whether the diagnosis and treatment for all these patients had been optimal and to find the reasons for their deaths.

There was a more than adequate reason for the deaths of five of these patients. The three individuals with a Ps of 0.8 were in cardiorespiratory arrest on arrival in the Accident and Emergency Department. One had a penetrating cardiac wound and underwent thoracotomy within minutes of arrival but without response. The second

Fig. 2 Time of arrival of patients.

Fig. 3 Type of trauma.

Fig. 4 Range of injury severity scores.

was a patient who had a combination of extensive thermal and smoke inhalation injury. The third had a severe head injury which was confirmed to be the principal cause of death at autopsy. While these patients were nominally given a Ps of 0.8, the fact that they arrived in cardiorespiratory arrest together with the nature of their injuries, and with the short periods of time from admission to formally pronouncing life extinct (all less than 20 min), we did not feel that these deaths were due to diagnostic or treatment failures.

There were, however, four deaths (8%) in the study in which evidence accrued to show that management was either inadequate or inappropriate, and it was therefore felt that death could potentially have been avoided (Table 1).

Fig. 5 Approximate probabilities of survival.

Table 1 Patients who had inadequate or inappropriate treatment

Name	Age	Injury severity score	Probability of survival	Problem
CR	85	34	0	Fracture L4 missed hypovolaemic following fractured pelvis. CVP line very late.
PP	74	38	0	Transfer. Overtransfused. No CVP line.
CL	57	43	0	Transfer. Thoracic, pelvic and abdominal injuries not treated prior to transfer GCS 4 but not intubated for transfer.
KM	23	66	0	Transfer. Thoracic injury not treated. GCS 3 but not intubated.
DS	21	75	0	Bilateral pneumothoraces not treated despite use of MAST suit.
JH	27	75	0	Thoracic injury not treated. Haemothorax.
TG	50	75	0	Thoracic injury not treated. No fluid replacement. Haemopneumothoraces.
SH	21	50	0.1	Thoracic injury not treated. Flail segment and bilateral haemothoraces.
CF	22	45	0.3	Thoracic injury not treated—pneumothoraces.
WM	24	45	0.3	Thoracic injury not treated—bilateral pneumothoraces.
JB	25	38	0.5	Thoracic injury treated too late—pneumothorax.
ET	53	26	0.6	Thoracic injury treated too late—cardiac stab wound.

CASE 11

A 25-year-old male motorcyclist was admitted having hit a wall on a country road at speed. On admission he was vocalizing and had 'good spontaneous respiration with no cyanosis'. Pulse was 80 per minute, BP 120/50mmHg, Glasgow Coma Scale (GCS) $E3 + V3 + M6 = 12/15$. He was noted clinically to have a right-sided flail segment and chest X-ray confirmed fractures of the second to seventh ribs on the right side. No haemopneumothorax was seen but there were bilateral lung contusions; these were not commented on in the clinical notes. There is no record of blood gas results or samples taken and only one chest X-ray was taken. Initial treatment consisted of supplemental oxygen, a single intravenous line and the insertion of a urinary catheter.

One hour after admission his respiration became laboured and the patient had a respiratory arrest. He was intubated and developed ventricular fibrillation. A DC shock at 200J was administered and he went into asystole from which he did not recover. During the attempted cardiac resuscitation, bilateral chest drains were inserted which relieved a right-sided tension haemopneumothorax and a left-sided pneumothorax. He was pronounced dead 1 h 39 min after arrival. From information derived at post-mortem, the ISS was 38 and Ps 0.5. He was attended by middle grade medical staff from the Departments of Accident and Emergency Medicine, Anaesthetics, Neurosurgery and General Surgery.

CASE 12

A 53-year-old female was admitted having been stabbed once in the upper anterior right side of chest. There was surgical emphysema and poor air entry over the right hemithorax. The pulse was 110 per minute and BP 100/60mmHg. Chest X-ray showed a right lower zone opacity, correctly diagnosed as a loculated haemothorax. A chest drain was inserted but was 'non-functional'. The patient subsequently developed a bradycardia and clinical features of cardiorespiratory arrest. A second right-sided chest drain was inserted without improvement. Resuscitation was continued and thoracotomy performed. At thoracotomy a single wound was found in the right atrium. This was plugged with a finger and internal cardiac massage carried out. There was still no response and the patient was declared dead 1 h after admission. The ISS was 26 and Ps 0.6.

CASE 10

A 24-year-old male pedestrian was admitted having been knocked down by a heavy vehicle. He was self-ventilating on admission with a pulse of 100 per minute, a BP of 70/30 mmHg and a GCS $E1 + V1 + M1 = 3/15$. Endotracheal intubation and IPPV with 100% oxygen were commenced. Chest X-ray showed fractures of the second to fifth and of the twelfth ribs on the left with bilateral 'lung contusions'. The radiologist's report,

however, states that there was bilateral extensive opacification compatible with oedema or haemorrhage and that there were bilateral pneumothoraces together with pneumopericardium. The autopsy showed the lungs to be normal but there were 'huge' bilateral haemopneumothoraces. No chest drainage was instituted and the patient died 1½ h after admission. The ISS was 45 and Ps 0.3.

CASE 8

A 21-year-old male pedestrian was admitted having been knocked down by a car. He was deeply unconscious on admission with a GCS E1 + V1 + M1 = 3/15. He had palpable pulses but rapidly developed ventricular fibrillation. Abrasions were noted over left scapula and abdominal wall. There was a penetrating abdominal wound in the left iliac fossa and a compound fracture of the right femur. No venous access was achieved and there is no record of defibrillation. The bilateral haemothoraces and left flail segment shown at post-mortem were not diagnosed. The patient was declared dead 11 min after admission. The ISS was 50 and Ps 0.1.

A closer examination of the remaining case histories revealed a further eight cases (16%) in whom treatment, as recorded in the clinical records, can in retrospect be considered to be less than ideal (Table 1). However, these errors were not thought to have had a significant influence on the patient's final outcome. Seven of these patients had a Ps of 0 (Table 1). The one patient, case 9, who had a probability of survival of 0.3 had sustained a cardiac arrest prior to arrival and had a very severe head injury in addition to the missed pneumothorax. At post-mortem a right temporal vault fracture which extended into the base of the middle fossa was found. There was also subarachnoid haemorrhage covering the entire surface of the brain together with intraventricular haemorrhage and cerebral oedema. An important additional factor in three of these patients was that they had been transferred from other hospitals to the Royal Infirmary. None of them were adequately assessed prior to transfer and in two, insufficient precautions were taken to secure the airway prior to transfer.

DISCUSSION

Injuries caused less than 5% of the deaths that occurred in the UK in 1986 (Scottish Health Statistics, 1986/87, Welsh Office, 1987, Department of Health and Social Security, 1987). A significant proportion of these deaths will have been a consequence of multiple injuries. Precise figures for major trauma do not exist in the UK. This is principally because the International Classification of Diseases (World Health Organization, 1975 Revision) does not include a category for multiple injuries or major trauma which is comparable to an ISS of greater than 15. Another important factor is the lack of interest, until recently, in the management of major trauma in the UK. This is unfortunate because the costs of multiple injuries in human and financial terms are disproportionately high. The treatment of multiple injuries is complex and requires a

good deal of experience. This study is an attempt at self-audit by a major accident and emergency unit and has revealed a number of important points.

We, like others before us, have found injury severity scoring is relatively simple. It does have recognized limitations, however, particularly when used for penetrating trauma (Stoner *et al.*, 1977, Beverland & Rutherford, 1983). ISS on its own is a rather inadequate predictor of outcome. The best and most widely accepted method of predicting outcome is the TRISS method (Boyd & Tolson, 1987). This method combines ISS with the revised trauma score (RTS) and an allowance for age, using coefficients calculated from a North American database of almost 100 000 patients, to compute a Ps. Use of this method allows comparison with the standard of care that exists in America. Although this method has been used in the UK (Spence *et al.*, 1988), it has yet to be fully evaluated for UK patients. There is no UK database which could be used to calculate the co-efficients for UK patients and therefore it is not possible to show if there is a significant difference between the UK and North America.

We have used Bull's method for predicting survival rather than the TRISS method out of necessity rather than choice. The principal reason for this was absence from the patient's records of at least one of the physiological observations required for the RTS, making it impossible to calculate meaningful results with the TRISS method. Bull's method only takes account of the patient's age. The data used for Bull's method are now over 20 years old but they are from UK patients and a significant change has yet to be demonstrated in UK standards. One recent report shows that in England and Wales up to 33% of deaths from injury could have been prevented (Anderson *et al.*, 1988).

Some of the patients' ages were outwith the range of the table. The very elderly group over 85 years did not present any major problem for this analysis as they had injuries which would have been fatal even at a much younger age. The children included were treated for analysis purposes as young adults. This was felt to be acceptable because although there is very little information available about children in this context, what exists suggests that they have the same chance of survival as young adults (Bull, 1978).

The principal reason for calculating a Ps is to focus attention on those patients who have died inappropriately; this facilitates further enquiry into the reasons for this. Calculating Ps is not meant to replace audit by peer review but to augment it (Boyd & Tolson, 1987). It should be stressed, however, that any clinical decisions with regard to resuscitation should not be based upon such values.

All four patients in whom death was considered to be preventable, were admitted at night and had severe chest injuries. For this group, appropriate specific therapy was either delayed or the severity of their condition was unrecognized. The ISS for these patients range from 26–50 with probability of survival scores from 0.1 to 0.6.

This study also highlights the difficulties involved in diagnosing serious chest injury. This has led us to suggest that for patients who present in cardiac arrest with blunt trauma, bilateral chest drains should be immediately inserted, followed where appropriate by emergency thoracotomy. Patients with penetrating chest injuries who do not have cardiac output should have immediate thoracotomy initially on the side of the injury.

The fact that the majority of these patients arrive outwith 'normal' working hours confirms the need to provide continuous senior medical staff cover for accident and emergency departments. In addition, there must be easy and rapid access to appropriate surgical, anaesthetic and intensive care facilities 24 h a day.

In the light of this study, we would caution against limiting trauma audit to 'unexpected' triumphs or failures. Invaluable lessons can be learned from all trauma deaths and regular audit is mandatory. All those clinicians involved in the provision of trauma care should subscribe to this regular audit and be encouraged to attend the autopsies performed. An extension of this type of study to all trauma cases, irrespective of survival, is necessary, and we are currently performing such studies in a prospective fashion.

REFERENCES

- Abbreviated Injury Scale* (1985) Revision. American Association for Automotive Medicine, Arlington Heights, USA.
- Anderson I. D., Woodford M., DeDombal F. T. & Irving M. (1988) Retrospective study of 1000 deaths from injury in England and Wales. *British Medical Journal* **296**, 1305–8.
- Baker S. P., O'Neill B. *et al.*, (1984) The injury severity score: development and potential usefulness. *Proceedings of the American Association for Automotive Medicine* **18**, pp 58–74.
- Beverland D. E. & Rutherford W. H. (1983) An assessment of the validity of the Injury Severity Score when applied to gunshot wounds. *Injury* **15**, 19–22.
- Boyd C. R., Tolson M. A. & Copes W. S. (1987) Evaluating trauma care: the TRISS method. *The Journal of Trauma* **27**, 370–8.
- Bull J. P. (1978) Measures of severity of injury. *Injury* **9**, 184–7.
- Department of Health and Social Security (1987) *On the state of the public health for the year 1986*. HMSO, London.
- Department of Health and Social Security (1987) *Health and Personal Social Services Statistics for England, 1987 edition*. Government Statistical Service, London.
- Scottish Health Statistics (1986/87) ISD Publications. Information and Statistics Division, Common Services Agency, Edinburgh.
- Spence M. T., Redmond A. D. & Edwards J. D. (1988) Trauma audit—the use of TRISS. *Health Trends* **20**, 94–7.
- Stoner H. B., Barton R. N., *et al.*, (1977) Measuring the severity of injury. *British Medical Journal* **2**, 1247–9.
- Welsh Office (1987) *Health and Personal Social Services Statistics for Wales, No 14 1987*. Government Statistical Service, London.
- World Health Organisation. (1977) *Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death, 1975 Revision*. HMSO, London.