Setting up new medical services

The trauma team - a system of initial trauma care

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Summary

Trauma remains the leading cause of death under the age of 35 years. England and Wales lost 252 000 working years from accidental deaths, including poison, in 1992. In this country, preventable deaths from trauma are inappropriately high. In many hospitals there are not enough personnel; in the majority, there are no recognisable trauma care systems, which can reduce preventable deaths to a minimum. The appropriateness of trauma centres for this country is being assessed in Stoke-on-Trent, and a report is due out later this year. Even if the recommendation is made to establish such centres, it is unlikely that many will be set up. Consequently most hospitals will have to rely on their own resources to set up and run a trauma team. This type of trauma care system is the subject of this article.

Keywords: trauma team, triage, audit

Even though fatalities from trauma have fallen over the past 30 years, it remains the commonest cause of death under the age of 35.^{1,2} Twice as many boys as girls under 15 years die from trauma and this ratio increases to 4:1 between the ages of 15 and 34 years, inclusive. England and Wales lost 198 000 male working years from accidental deaths, including suicide, in 1992.² This was ahead of all the other disease groups. In the same year, 54 200 female working years were lost, third place behind deaths from malignant neoplasms and circulatory system diseases.

Death after trauma is trimodal.^{3,4} In North America, half of all deaths occur in the first peak, at or shortly after the accident. Most of these are due to unsalvageable, major neurological or vascular injuries. Thirty per cent of deaths occur in the second peak, some hours after injury, when resuscitation and stabilisation are critical. These patients die because of potentially treatable airway, breathing, and circulatory problems. In the third peak, days or weeks after injury, the remaining deaths occur from multisystemic organ failure, acute respiratory disease syndrome, and overwhelming infection.⁴ Inadequate resuscitation, during the immediate or early postinjury period, leads to an increase in mortality in the third peak.⁵

In the UK, the distribution of trauma death differs from that in North America.⁶ Generally, 27–53% of deaths in severely injured patients that reach hospital alive in the UK are preventable.^{7–9} However, in a Scottish study, 76% of deaths occurred in the first peak, with 7 and 17% occurring in the second and third peaks, respectively.⁶ This may be due to better management of patients who would otherwise die of preventable causes in the latter two peaks, or because of differences in the mechanism of injury. In Northern Ireland, only 3–15% of deaths were preventable; this was attributed to greater consultant participation in trauma management.¹⁰ Nevertheless, these Northern Ireland figures are still above acceptable international standards.

Despite these dismal details, there are no adequate trauma care systems.^{11–13} In a survey of 33 British hospitals, 57% had a senior house officer in charge of the initial resuscitation of patients with injury severity scores (ISS) of 16 or over.¹⁴ In one hospital, junior house officers saw 53% of all patients who presented with an ISS of 16 or over, and in 74% of cases, their management was unsatisfactory.¹⁵ Of hospitals that provide major trauma services, 21% have no accident and emergency consultants, 80% have no access to a neurosurgical or cardiothoracic surgeon, and 6% have no intensive-care facilities.¹³

After reviewing emergency services, a Working Party of the Royal College of Surgeons of England have proposed the establishment of trauma centres,¹⁶ in order to reduce mortality figures to near those obtained in the USA.^{17–19} For example, in a county with a regionalised trauma centre, only 1% of deaths were preventable compared to 43% in an adjacent county without one.¹⁷ Aggressive resuscitation and prompt life-saving operations were responsible for the improvement in survival. Ten per cent of 4716 American hospitals surveyed between 1980 and 1991 were trauma centres.²⁰ In 1991, the first trauma centre in the UK, the North Staffordshire Hospital Centre, Stoke-on-Trent, was established to evaluate its cost-effectiveness and appropriateness.²¹ Their report is expected this year.

Which trauma care system ?

The wholesale introduction of an American-style trauma care system may not be suitable for the UK.^{10,12} This is because of its heavily populated areas, shorter transportation distances and marked involvement in trauma care by district general hospitals.^{10,12,22} In any event, if trauma centres were introduced, there would be few level-1 centres.^{12,23} The estimated cost of

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Some characteristics of level 1 trauma centres

- trauma team
- 24-h cover by all surgical and nonsurgical subspecialties
- ICU, with a minimum nurse:patient ratio of 1:2
- acute haemodialysis capabilities
- local or regional burns and head injury units
- full radiological service — angiography, ultrasound, NMR, CT
- 24-h theatre with operating microscope, cardiopulmonary bypass and craniotomy capabilities
- 24-h full laboratory services
- quality assurance, research and training programmes

Box 1

Objectives of the trauma team

- resuscitate and stabilise patient
- determine nature and extent of injuries
- prioritise injury
- prepare and transport patient for definitive care — theatre, another hospital
- treat patient holistically and humanely

Box 2

Functions of team leaders

Doctor

- co-ordinates specific tasks of individual members
- checks breathing, assimilates clinical findings
- prioritises investigations
- liaises with attending specialists
- ascertains mechanism of injury, pre-hospital findings, preceding treatment
- depending on available skills, does thoracotomy, pericardiocentesis, if needed

Nurse

- co-ordinates nursing team
- prepares sterile packs, brings necessary equipment
- assists circulation nurses
- records clinical and laboratory findings, drug infusion, vital signs

Box 3

running eight 'ideal' centres (box 1),²⁴ to serve the whole country, is at the upper limit of, or exceeds the equitable sum available within the National Health Service.²³ For most hospitals, trauma teams would not only be adequate, but would probably be within their financial capability.^{11,25}

Although the trauma team is an integral part of the trauma centre, on its own, in non-designated trauma centres, it is still effective at improving patient survival.^{10,26-28} This is similar to the use of a cardiac arrest team in managing cardiorespiratory arrests.²⁹ Some hospitals already use trauma teams, but there are problems with efficiency and call-out criteria.^{25,26,28,30,31} Of 15 hospitals with general accident and emergency departments in the Trent region, only five (no teaching hospitals) had trauma teams.³²

Prehospital care

Half to three-quarters of all trauma fatalities occur before arrival in the hospital, most of which are not preventable.^{6,8,9,33} Though hypovolaemia is responsible for the majority of preventable deaths,⁴ fluid infusion at the site of accidents does not improve survival.^{34,35} In severe injuries (ISS of 25-50), attempts at fluid infusion led to delay in transportation to the hospital.³⁴ These delays are considered by some to be a major cause of preventable deaths.⁴

A computer model showed that patients only benefited from prehospital infusions if bleeding rate was between 25 and 100 ml/min, infusion rate was equal to the bleeding rate, and the prehospital travel time was greater than 30 minutes.³⁶ During transportation, the average infusion rate was 17-47 ml/min³⁴ and the average volume infused was 700 ml.³⁶ Travel time greater 30 minutes is unusual in this country.^{9,12,22,35} On this basis, prehospital infusion is therefore unjustified.^{34,35} The emphasis should be on rapid transportation of patients, except in those 5-10% who need advanced life support.^{12,22,35}

The field team should be in communication with the receiving hospital, with information on the patient's state, the nature of the incident, and the estimated time of arrival.³⁷ Using standard field triage criteria (figure),³⁸ the field team activates the trauma team if necessary.

The trauma team

The objective of any trauma care system is to, "Assure optimal and equitable care for all trauma victims, prevent unnecessary death and disability from trauma, contain cost and assure quality of trauma care throughout the system".³⁹ The aims of the trauma team are summarised in box 2.³⁷ The team should be available at all hours, since about 75% of patients present between 17.00 and 09.00 h.^{9,15,33} The reported number of team members varies from two to 10,^{32,40-42} but size does not primarily determine the team's speed and efficiency. The optimum number is between five and eight.⁴⁰ Teams with less than five members are pressed to complete their tasks, and those with more than eight tend to fragment, with individuals not listening or reporting to the team leader.⁴⁰ This often leads to unnecessary procedures.

COMPOSITION

The composition of the team is vital to its function and efficiency. The medical team members should come from the surgical, accident and emergency, orthopaedic, and anaesthetic departments.^{25,26,30,32,41} An optimum team consists of a team leader, an airway doctor, an anaesthetist or intensive care clinician and two circulation doctors.³⁷ Similarly, the nursing team should consist of a team leader, an airway nurse and two circulation nurses. The presence of a radiographer is essential.^{25,37,41} A relatives' nurse is necessary to liaise with family members. The functions of the various members are summarised in boxes 3-6.³⁷

The importance of a paediatrician in the trauma team for paediatric cases is unclear. Some units routinely request their services,^{26,41} but over a six-year period, in a level-1 'adult' trauma centre, no preventable deaths occurred in 1115 paediatric trauma patients managed.⁴³ All adequately trained trauma doctors, irrespective of discipline, should be able to manage patients in any age group.

The presence of a surgical registrar is vital to proper management.^{24,44} Laparotomy, in a haemodynamically unstable patient, forms part of the initial resuscitation.¹² Sixty-two per cent of preventable deaths after trauma in England and Wales were injuries that would normally be treated by operation; most of these were intra-abdominal.⁸ Only 46% of patients judged to require early operation arrived in theatre within two hours.¹⁴

TEAM LEADER

A leader to co-ordinate the team's activity is essential (box 3).^{24,44} The lack of one leads to delays in the resuscitation and assessment of injured patients.³⁰ Ideally, the leadership should rotate between the various specialists involved on a daily or weekly basis.^{25,40,41,45} Some have argued that, because operative interventions are often necessary, a surgeon should lead.^{24,44} However, we believe that it is more important to have a leader trained in trauma management, with the appropriate experience.⁴⁰ It follows therefore, that any specialty member appropriately trained, could lead the team. The tendency for general surgeons to favour peritoneal lavages, and emergency physicians, intubation,⁴⁵ is discouraging. It should be expected that all team leaders are competent in all procedures needed in the initial resuscitation of the injured patient.⁴⁶

The effective discharge of the leader's duties is not dependent on seniority, but on proper training and experience.^{40,41} These must address the main pitfalls found in leaders' performances, which are in the areas of interpersonal communications, documentation of history, and full exposure of patients.⁴¹

Trauma team activation

The trauma team should be waiting in the emergency room for the patient's arrival.^{12,24,27} To this end, the field team need to use standard field triage criteria (figure) to activate the trauma team of the receiving hospital.^{12,38,47} The use of the standard criteria has 100% sensitivity for detecting severely injured patients, while its specificity is about 40%.⁴² This inevitably leads to over-triage, especially for those who meet the mechanism-of-injury criteria alone.⁴⁷⁻⁴⁹

Shatney *et al* found that around 65% of all blunt trauma patients admitted to a trauma centre fulfilled only one mechanism-of-injury criterion.⁴⁷ Their mean ISS was 2.8 in adults, 2.4 in children, and only 1% had an ISS >15. A full trauma team saw 61% of patients with an ISS <5, at a cost twice that of those seen by the emergency department doctors, without any improvement in outcome.⁴⁹ If patients fulfilled the mechanism-of-injury criteria alone, the sensitivity of detecting severe injury was still 100%, but the positive predictive value was only 38% and specificity was 0%.⁴⁸

Compounding the poor predictive value of mechanism-of-injury is that, up to 40% of patients that fulfil one of the six most common vehicular field triage criteria have an ISS >15.⁴⁸ Furthermore, of patients with prolonged extrication time, 39-65% had an ISS >15 and a mortality of 13%.^{48,50} A quarter of patients ejected from a car, or present in a car in which someone died, or in a car deformed by >75 cm, and 35% of pedestrians struck at >20 mph had an ISS >15.⁵⁰

Further causes of over-triage include that fact that up to 38% of patients with an ISS <4 may have alcoholic intoxication and thus hypotension and/or low Glasgow Coma Scale (GCS).⁴⁸ In conscious, injured patients without head injury, blood alcohol concentration correlated significantly with GCS but not with the severity of injury.⁵¹ Severe intoxication, as defined by blood concentration greater than 240 mg/100 ml, may reduce GCS by two or three points. These are some of the factors which can lead to over-triage, however, the American College of Surgeons recommend that about 50% over-triage is needed to prevent under-triage.³⁸

Some hospitals use differential trauma alert, by which the emergency room doctor, but not the trauma team, initially assesses patients with vehicular criteria alone.^{42,47} These changes in the standard field triage criteria have led to under-triage,^{42,52} although specificity rose to 61-68%, while sensitivity only fell to 83-99%.^{42,48} Any changes to the standard criteria should be studied prospectively. A core, reduced team seemed not to affect the outcome in paediatric cases.⁵³

Organisation and activity

Individuals in an efficient team work simultaneously (horizontal organisation) with tasks allocated before the patient's arrival.^{30,31,37,54} Personnel must wear protective clothing (rubber gloves, plastic aprons, glasses), as all blood and body fluids should be assumed to carry HIV and hepatitis viruses. A final check of the resuscitation room equipment should be carried out at this stage. When the patient arrives, he/she is transferred from the stretcher to the trolley with the head and neck stabilised. It is very important that the spinal column is not rotated and that there is no exacerbation of current injuries.

During the primary survey and resuscitation, members should follow a strict

Figure Field triage criteria

Functions of airway personnel
<i>Doctor</i> <ul style="list-style-type: none">clears and secures airway, takes correct cervical spine precautionsinserts central and arterial lines if required <i>Nurse</i> <ul style="list-style-type: none">assists doctor, establishes rapport with patient, gives psychological support Information to the patient passes through her

Box 4

Functions of circulation personnel
<i>Doctor</i> <ul style="list-style-type: none">assists in removal of patient's clothesestablishes infusions and takes blood for investigationsinserts urinary catheter, chest draindepending on skill, can do other procedures <i>Nurse</i> <ul style="list-style-type: none">assists doctor, measures vital signs, connects patient to monitorsmonitors fluid balance

Box 5

Functions of other personnel
<i>Relatives' nurse</i> <ul style="list-style-type: none">cares for patient's relativesliaises between trauma team and patient's relatives <i>Radiographer</i> <ul style="list-style-type: none">takes three standard X-rays for each blunt-trauma patient: chest, pelvis and lateral cervical spine. Selective approach for penetrating-trauma victims

Box 6

Objectives of primary survey and resuscitation

- assessment and stabilisation of airway
- stabilisation of cervical spine
- assessment and correction of ventilatory problems
- assessment of haemodynamic state
- control of overt haemorrhage
- insertion of large-bore peripheral cannulae
- blood samples for laboratory tests
- assessment of conscious level
- establishment of supportive contact
- removal of clothes and covering with warm blankets
- connection of monitors, recording initial vital signs
- insertion of nasogastric tube, if appropriate

Box 7

Life-threatening thoracic conditions

- airway obstruction
- tension pneumothorax
- cardiac tamponade
- open pneumothorax
- massive haemothorax
- flail chest

Box 8

Functions of co-ordinator

- improve the present, uncoordinated referral system
- establish a designated multidisciplinary team for patients
- co-ordinate patient management by regular interspecialty meetings, handovers, information sharing
- develop and implement hospital rehabilitation policies
- perform and monitor disability assessments
- prepare for discharge, follow-up and community care

Box 9

routine with allocated tasks done simultaneously.⁴⁶ The team must ensure Airway and cervical spine control, assess Breathing, Circulation, Disability or neurological status and Expose the patient (ABCDE) to achieve the objectives outlined in box 7. A well-practised team will complete this phase within 10 minutes.³⁷

During the assessment of breathing, life-threatening thoracic conditions (box 8) must be searched for and treated. If bleeding continues despite aggressive resuscitation, the patient must be transferred to theatre for appropriate surgery. A delay of 20–30 minutes in carrying out life-saving procedures related to airway, breathing and circulatory control, leaves the patient in a worse physiological state than when they arrived.^{12,31} The time taken to perform these procedures is predictive of outcome. After the primary survey, the nonessential members, the circulatory doctors and nurses, can leave.

The secondary survey involves a complete history and systematic examination to determine the full extent of injury, analysis of clinical, laboratory and radiological results, and formulation of a management plan. This is done in a co-ordinated fashion.³⁷ Ideally, the team should aim towards completing both the primary survey and resuscitation, and the secondary survey in half an hour.³¹ At the end of the secondary survey, the patient will need to be transferred to the place where definitive care can take place. Ideally, the future management should involve a trauma co-ordinator who can facilitate the input of different specialties involved, and streamline them (box 9).^{55,56} This role, played by a senior nurse, is imperative for quality improvement.⁵⁵

Education and training

The minimum requirement for team members is to pass the Advanced Trauma Life Support (ATLS) course.^{12,54} For the leader, experience within an organised trauma team is also essential.¹² Unfortunately, these minimum standards are often not met. Only 5% of non-accident and emergency department staff have taken the ATLS course in the South East Thames Region of London.⁵⁷ In the country though, the figure is nearer 75% (Royal College of Surgeons, personal communication). While only 11% of consultant anaesthetists in the Trent Region have taken the course,³² the proportion of general surgeons in the country taking part has doubled to 20% since its inception. The Royal College of Surgeons of England introduced the course, under licence from the American College of Surgeons, in 1988 and 1990 for doctors and nurses, respectively.^{58,59} The number of courses have increased from one in 1988 to 112 in 1994, with 5027 doctors trained to date. The teaching of trauma in medical schools varies greatly and is without any minimum standard.⁶⁰

Hospitals should arrange local induction courses for new team members while waiting for the ATLS course.^{59,61,62} Despite the considerable improvement in skills achieved,⁶² these courses should not replace ATLS,⁵⁹ which is the international language of all trauma surgeons.⁶³ Senior medical students benefit from ATLS courses, with improved skills comparable to doctors on the courses.^{64,65} It is desirable to have a reciprocal exchange of team members between trauma centres and district hospitals, and for members to participate as ATLS instructors.⁵⁴ At present, there are only 344 instructors in the UK (Royal College of Surgeons, personal communication) and more are needed.

The Trauma Nurse Care Course and the Advanced Trauma Nursing Course, are equivalent to ATLS and are basic requirements for nurses. Paramedics should attend the Prehospital Trauma Life Support Courses in addition to those needed for national training, and it should emphasis clinical judgement, practical skills, and field triage.¹²

Audit and assessment

The audit of team members and the system is integral to the trauma care process.^{24,55} This includes assessing individuals working alone and as part of the team. In both cases, feedback is important.^{41,66} The use of ongoing videotape to assess the team is beneficial.^{61,67} It allows for correction of conceptual and technical errors, elimination of wasted time, and reduction in resuscitation time.⁶⁷ Regular multidisciplinary trauma conferences are essential for the purposes of quality assurance through the critique of individual cases.²⁴ This audit process should extend to the activities of paramedical and nursing staff.

To aid comparisons between institutions, standard injury classifications have evolved. The most commonly used is the abbreviated injury scale, which measures the severity of anatomical injury. After computation, it gives the

Summary points

State of trauma care:

- male to female ratio is 4:1
- >250 000 working lives lost in 1992
- 27-58% of hospital deaths are preventable
- no organised trauma care system
- 21% of trauma-receiving hospitals have no A&E consultants
- no minimum standard for trauma teaching in medical schools

Trauma team:

- 5-8 members with defined roles
- team leader with proper training to be identified
- anaesthetic, surgical, and emergency department representatives
- tasks should be done simultaneously
- available at all hours
- activated based on field triage criteria
- be prepared before arrival of patient
- a co-ordinator for continuing management

Box 10

ISS.⁶⁸ The revised trauma score assesses physiological derangement, incorporating the respiratory rate, systolic blood pressure and GCS.⁶⁹

The ISS, revised trauma score, age and mechanism-of-injury score provide a measure of the probability of survival — the trauma and injury severity score methodology.⁷⁰ This methodology allows the comparison of trauma management outcome of individual hospitals to known standards and forms the statistical basis for the Major Trauma Outcome Study,⁷¹ a national database for the study and research of trauma systems. This provides an objective and quantitative basis for outcome comparisons between individual hospitals⁷¹ and is based at the North Western Injury Research Centre, Hope Hospital, Salford. It currently holds more than 40 000 cases from over 130 hospitals (M Woodford, personal communication).

Conclusion

A system of trauma care, the trauma team, may be within the financial capabilities of most general hospitals. The ideal team should be available at all hours and consist of five to eight appropriately trained personnel. The active involvement of surgical and anaesthetic doctors, along with accident and emergency physicians is very important. A leader is identified and tasks are allocated to members before the patient's arrival. Tasks must be done simultaneously, and the team should strive towards completing both primary and secondary surveys in half an hour. A trauma co-ordinator should oversee patients' further management in hospital and following discharge.

ATLS courses for all final year medical students should be a goal. Currently, the Royal Colleges of Surgeons and Anaesthetists and the faculty of Accident and Emergency are considering making ATLS certification compulsory for the postgraduate diplomas (MRCS, FRCS(A&E), FRCA), but this is hampered by insufficient instructors.⁵⁹ The audit of process and outcome is an essential part of the care system, as is feedback. An adequately trained and efficient trauma team^{46,54,72} must become a feature of every general hospital that accepts multiply injured patients, in order to address the loss of young lives at their prime.

- Office of Population Censuses and Surveys. *Mortality statistics*. Series DH1 no 25. London: HMSO, 1992.
- Office of Population Censuses and Surveys. *Mortality statistics*. Series DH1 no 27. London: HMSO, 1994.
- Trunkley DD. Trauma. *Sci Am* 1983; **249**: 20-7.
- Baker C, Oppenheimer L, Stevens B, Lewis FR, Trunkley DD. Epidemiology of trauma deaths. *Am J Surg* 1980; **140**: 144-50.
- Bitari D. Intensive care In: Westaby S, ed. *Trauma: pathogenesis and treatment*. London: Heinemann Medical Books, 1989.
- Wyatt J, Beard J, Gray A, Busuttill A, Robertson C. The time of death after trauma. *BMJ* 1995; **310**: 1502.
- Sen B, Maitra A. An audit of trauma deaths in Newcastle upon Tyne. *Br J Clin Pract* 1992; **46**: 13-5.
- Anderson ID, Woodford M, De Dombal FT, Irving M. Retrospective analysis of 1000 deaths from injury in England and Wales. *BMJ* 1988; **296**: 1305-8.
- Gorman DF, Teanby DN, Sinha MP, et al. The epidemiology of major injuries in Mersey Region and North Wales. *Injury* 1995; **26**: 51-4.
- McNicholl BP, Fisher RB, Dearden CH. Transatlantic perspectives of trauma systems. *Br J Surg* 1993; **80**: 985-7.
- Spencer JD. Why do our hospitals not make more use of the concept of a trauma team? *BMJ* 1985; **290**: 136-8.
- Driscoll PA. Trauma: today's problems, tomorrow's answers. *Injury* 1992; **23**: 151-8.
- Rowley DI. Trauma and trauma management. *J R Coll Surg Edinb* 1993; **38**: 246-7.
- Yates DW, Woodford M, Hollis S. Preliminary analysis of the care of injured patients in 33 British hospitals: first report of the United Kingdom major trauma outcome study. *BMJ* 1992; **305**: 737-40.
- Dearden CH, Rutherford WH. The resuscitation of the severely injured in the accident and emergency department - a medical audit. *Injury* 1985; **16**: 249-52.
- Royal College of Surgeons of England. *Report of the working party on the management of patients with major injuries*. London: RCS, 1988.
- West JG, Trunkley DD, Lim RC. Systems of trauma care. A study of two counties. *Arch Surg* 1979; **114**: 455-60.
- West JG, Coles RH, Gazzaniga AB. Impact of regionalisation. The Orange County experience. *Arch Surg* 1983; **118**: 740-4.
- Cales RH, Trunkley DD. Preventable trauma deaths: a review of trauma care systems development. *JAMA* 1985; **254**: 1059-63.
- Bazzoli GJ, MacKenzie EJ. Trauma centers in the United States: identification and examination of key characteristics. *J Trauma* 1995; **38**: 103-10.
- Redmond AD. The North Staffordshire Trauma System. *J R Coll Surg Edinb* 1993; **38**: 248-50.
- McNicholl BP. The golden hour and prehospital trauma care. *Injury* 1994; **25**: 251-4.
- O'Kelly TJ, Westaby S. Trauma centres and the efficient use of financial resources. *Br J Surg* 1990; **77**: 1142-4.
- American College of Surgeons' Committee on Trauma. Hospital and prehospital resources for optimal care of the injured patient. *Am Coll Surg Bull* 1986; **71**: 4-12.
- Sakellariou A, Lane RHS, McDonald PJ. The trauma team concept and its implementation in a district general hospital. *Ann R Coll Surg Engl* 1995; **77**: 45-52.
- Spencer JD, Gopalji B. Audit of 6 months' activity of a trauma team. *Injury* 1990; **21**: 68-70.
- Deane SA, Gaudry PL, Pearson I, et al. The hospital trauma team: a model for trauma management. *J Trauma* 1990; **30**: 806-812.
- Ingham Clark CL, Tabone-Vassallo M. Major trauma: a district general hospital experience. *Br J Surg* 1991; **78**: 230-233.
- Cope AR, Quinton DN, Dove AF, Sloan JP, Dave SH. Survival from cardiac arrest in the accident and emergency department. *J R Soc Med* 1987; **80**: 746-59.
- Heyes FLP, Perez-Avila CA. Introduction of a trauma team to a district general hospital. The Brighton experience. *Injury* 1991; **22**: 369-71.
- Driscoll PA, Vincent CA. Organizing an efficient trauma team. *Injury* 1992; **23**: 107-10.
- Highley DA. Review of the composition and use of trauma teams within the Trent Region. *J Accid Emerg Med* 1994; **11**: 183-5.
- Airey CM, Franks AJ. Major trauma workload within an English Health Region. *Injury* 1995; **26**: 25-31.
- Kaweski SM, Sise MJ, Virgilio RW. The effect of prehospital fluids on survival in trauma patients. *J Trauma* 1990; **30**: 1215-9.
- Deakin CD, Hicks IR. AB or ABC: pre-hospital fluid management in major trauma. *J Accid Emerg Med* 1994; **11**: 154-7.
- Lewis FR. Prehospital intravenous fluid therapy: physiologic computer modelling. *J Trauma* 1986; **26**: 804-15.
- Driscoll P, Brook S. Resuscitation and stabilization of the severely injured patient. In: Driscoll PA, Gwinnutt CL, Jimmerson CL, Goodall O, eds. *Trauma resuscitation. The team approach*. Basingstoke: Macmillan Press Ltd, 1993; pp 9-41.
- American College of Surgeons' Committee on Trauma. Field categorization of trauma patients. *Am Coll Surg Bull* 1986; **71**: 17-21.
- Esposito TJ. Trauma care systems. In: Gamelli RL, Dries DJ. *Trauma 2000. Strategies for the new millennium*. Austin, Georgetown: RG Landes Company, 1992; pp 1-14.
- Driscoll PA, Vincent CA. Variation in trauma resuscitation and its effect on patient outcome. *Injury* 1992; **23**: 111-5.
- Sugrue M, Seger M, Kerridge R, Sloane D, Deane S. A prospective study of the performance of the trauma team leader. *J Trauma* 1995; **38**: 79-82.
- Phillips JA, Buchman TG. Optimizing prehospital triage criteria for trauma team alerts. *J Trauma* 1993; **34**: 127-32.
- Rhodes M, Smith S, Boorse D, et al. Pediatric trauma patients in an "adult" trauma center. *J Trauma* 1993; **35**: 384-9.
- Yurt RW. Triage, initial assessment, and early treatment of the pediatric trauma patient. *Pediatr Clin N Am* 1992; **39**: 1083-91.
- Slagel SA, Skindzielewski JJ, Martyak GG, Brotman S. Emergency medicine and surgery resident roles on the trauma team: a difference of opinion. *Ann Emerg Med* 1986; **15**: 28-32.
- American College of Surgeons Committee on Trauma. *Advanced Trauma Life Support for Physicians*. Chicago: American College of Surgeons, 1993.
- Shatney CH, Sensaki K. Trauma team activation for "mechanism of injury" blunt trauma victims: time for a change? *J Trauma* 1994; **37**: 275-82.
- Simon BJ, Legere P, Emhoff T, Fiallo VM, Garb J. Vehicular trauma triage by mechanism: avoidance of the unproductive evaluation. *J Trauma* 1994; **37**: 645-9.

- 49 Hoff WS, Tinkoff GH, Lucke JF, Lehr S. Impact of minimal injuries on a level 1 trauma center. *J Trauma* 1992; 33: 408-12.
- 50 Esposito TJ, Offner PJ, Jurkovich GJ, Griffith J, Maier RV. Do prehospital trauma center triage criteria identify major trauma victims? *Arch Surg* 1995; 130: 171-6.
- 51 Brickley MR, Shepherd JP. The relationship between alcohol intoxication, injury severity and Glasgow Coma Score in assault patients. *Injury* 1995; 26: 311-4.
- 52 West JG, Murdock MA, Baldwin LC, Whalen E. A method of evaluating field triage criteria. *J Trauma* 1986; 26: 655-9.
- 53 Singh R, Kissoon N, Singh N, Girotti M, Lane P. Is a full team required for emergency management of pediatric trauma? *J Trauma* 1992; 33: 213-8.
- 54 American College of Surgeons' Committee on Trauma. Qualifications of trauma-care personnel. *Am Coll Surg Bull* 1986; 71: 13-6.
- 55 Mitchell FL, Thal ER, Wolferth CC. Analysis of American College of Surgeons trauma consultation program. *Arch Surg* 1995; 130: 578-84.
- 56 Hetherington H, Earlam RJ. Rehabilitation after injury and the need for coordination. *Injury* 1994; 25: 527-31.
- 57 Brennan L, Sage FJ, Simpson A. Major incident planning in South East Thames Region: a survey of medical staff awareness and training. *J Accid Emerg Med* 1994; 11: 85-9.
- 58 Driscoll P, Wells C. Trauma care since 1988. *Health Trends* 1990; 22: 119-20.
- 59 Hall DJ, Williams MJ, Wass AR. Life support courses for all. *J Accid Emerg Med* 1995; 12: 111-4.
- 60 O'Dowd JK, Spencer JD. An audit of university education in trauma and orthopaedic surgery in Great Britain. *J R Soc Med* 1992; 85: 211-3.
- 61 Hassan TB, Hickey FG. Trauma team concepts in the UK: tailoring resources to meet demand. *J Accid Emerg Med* 1995; 12: 162-3.
- 62 Gautam V, Heyworth J. A method to measure the value of formal training in trauma management: comparison between ATLS and induction courses. *Injury* 1995; 26: 253-5.
- 63 Collicott PE. Advanced Trauma Life Support (ATLS): past, present, future. 16th Stone Lecture, American Trauma Society. *J Trauma* 1992; 33: 749-53.
- 64 Ali J, Cohen R, Reznick R. Demonstration of acquisition of trauma management skills by senior medical students completing the ATLS program. *J Trauma* 1995; 38: 687-91.
- 65 Ali J, Howard M. The Advanced Trauma Life Support course for senior medical students. *Can J Surg* 1992; 35: 541-45.
- 66 Hanson JM, Johnson G, Clancy MJ. The effect of audit and feedback on data recording in the accident and emergency department. *J Accid Emerg Med* 1994; 11: 45-7.
- 67 Townsend RN, Clark R, Ramenofsky ML, Diamond DL. ATLS-based videotape trauma resuscitation review: education and outcome. *J Trauma* 1993; 34: 133-8.
- 68 Baker SP, O'Neill B, Haddon W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 1974; 14: 187-96.
- 69 Champion HR, Sacco WJ, Copes WS, et al. A revision of the trauma score. *J Trauma* 1989; 29: 623-9.
- 70 Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. *J Trauma* 1987; 27: 370-8.
- 71 Champion HR, Copes WS, Sacco WJ, et al. The major trauma outcome study: establishing national norms for trauma care. *J Trauma* 1990; 30: 1356-65.
- 72 Oakley PA. Setting and living up to national standards for the care of the injured. *Injury* 1994; 25: 595-604.