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TRAUMA Grapevine

Contents:

Introduction

Trauma remains a major issue for provision of health care in Australia with an estimated 50 admissions, 133 emergency department presentations and 1400 private doctor visits per single trauma death. These figures, in themselves staggering, often don't show the suffering behind the statistics. Victoria has taken a recent lead in an attempt to address trauma systems, providing a comprehensive review of trauma and emergency services in Victoria with a final report to the Ministerial Task Force on Trauma and Emergency Services - with a working document which is comprehensive and makes many recommendations which will have implications, not just to the state of Victoria but throughout Australia. The report deals with key regional issues, system organisation and management, triage and transfer protocols, retrieval and transfer, quality management, education and training, research, service and technology development and funding. It makes -commendable reading.
Liverpool Hospital offers a variety of educational opportunities in Trauma ranging from honorary trauma fellowships, visiting general practitioners training in trauma, opportunities for time shares in the Emergency Department and the trauma ward, trauma radiography, student attachments and ambulance officers interactive sessions. Should you wish to avail of any of the options that we may have on offer, please do not hesitate to contact us, or visit our web site.

In this issue Dr. Michael Parr discusses the management of pulmonary contusions.

Michael Sugrue

Pulmonary Contusion

Michael Parr, Intensive Care Unit, Liverpool Hospital

The current ATLS®/EMST manual states that pulmonary contusion is the most common potentially lethal chest injury. The manual goes on to say, "patients with significant hypoxia (ie. PaO_2 <65 mmHg or 8.6Kpa on room air, SaO_2 <90%) should be intubated and ventilated within the first hour of injury." What is wrong with this statement? Firstly, all severe trauma patients should be receive high concentrations of oxygen, it would therefore be inappropriate to perform blood gas analysis on patients with chest injuries breathing room air. Secondly, simple manoeuvres such as adequate oxygen administration (by open-mask or tight-fitting (e.g. CPAP), provision of effective analgesia and volume resuscitation may result in adequate oxygenation and avoid the need for and risks of intubation and mechanical ventilation.

BACKGROUND

Up to 25% of trauma fatalities have predominant or associated thoracic injury and pulmonary contusion is a common finding.

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Pulmonary Contusion

Continued

However, there is a no satisfactory definition of what constitutes a (significant) pulmonary contusion. Mechanisms of trauma and X-ray changes are not specific and may not differentiate contusion from aspiration, fat embolism or secondary acute lung injury (ALI)/acute respiratory distress syndrome (ALI/ARDS). It is also common for several of these pathologies to coexist. There is some data that suggest that 40-57% of pulmonary contusions require mechanical ventilation but this is largely based on data from the 1980s and probably does not reflect current practice.

PATHOPHYSIOLOGY

Disruption of alveolar capillary integrity results in intra-alveolar haemorrhage and oedema. CT scanning or thoracotomy may demonstrate pulmonary laceration. The consequences are reduced surfactant, reduced compliance, increased resistance, atelectasis, reduced FRC, V/Q mismatch, increased shunt and dead space which all contribute to an increase in the work of breathing and oxygen requirement while there is a reduced oxygen reserve. The clinical effects may progress over 24-48 hours. Inflammatory cell activation increases the release of inflammatory mediators with the potential to cause a secondary ALI or ARDS. The inflammatory response results in a capillary leak that that may become generalised affecting non-traumatised areas of the lung.

INVESTIGATION

The chest X-ray may be unimpressive initially, progressing to a total "white out" over a period of hours. The X-ray appearance of contusion may have little correlation with the physiological effects and the changes seen often lag behind the physiology. It is also important to remember that a pneumothorax may be present and can be missed in up to 30% of supine films when the classical apico-lateral pneumothorax is less common. (Tocino). Clues to the presence of a pneumothorax include basal hyperlucency, distinct visualisation of the diaphragm which may be depressed, a distinct cardiac border and deepened costophrenic sulcus.

Fractured ribs as an indicator of the severity of the chest trauma may not be present particularly in children and young adults with compliant skeletons (Fig 1).

Continuous pulse oximetry and serial blood gas analysis will ensure that adequate oxygenation is achieved and allow a progressive estimate of the degree of pulmonary dysfunction. These investigations are however no replacement for clinical assessment of respiratory distress by physical examination.

MANAGEMENT

The general management principles that apply to severe trauma patients still hold. The priorities are to ensure adequate oxygenation and perfusion while optimising conditions for the healing process. Monitoring of respiratory and cardiovascular function is essential bearing in mind that the patient may deteriorate over a 24-48 hour period. This is best done in an HDU/ICU facility for all but minor pulmonary contusions. All patients should receive controlled humidified oxygen. Interventions will be guided by the degree of physiological abnormality. The indications for assisted ventilation include:

- Manifest or impending respiratory failure (refractory hypoxaemia and hypercarbia)
- Ineffective cough and inability to clear secretions
- Pre-existing pulmonary disease (COPD, bronchiectasis, kyphoscoliosis)
- Gross obesity
- Associated large flail segment (as they will stabilise more rapidly with less residual chest deformity)

MODES OF ASSISTED VENTILATION

There is no good evidence to support the use of any particular mode of ventilatory support over another. While the benefits of non-invasive ventilation methods have now been demonstrated to be beneficial in avoiding intubation particularly in patients with COPD, this method has not been adequately investigated in thoracic trauma victims to allow evidence based statements. However, non-invasive ventilatory support may be preferable to invasive techniques even in moderate-severe cases of pulmonary contusion. As long as effective analgesia is provided, the patient is able to cough and the patient can tolerate a tight-fitting mask (which may not be feasible because of facial fractures). The advantages of non-invasive respiratory support are largely due to avoiding the need for a tracheal tube, thereby reducing the requirement for anaesthesia, neuromuscular blockade, sedation, maintaining speech and reducing the risk of infection. The other main disadvantages of ventilation are adverse cardiovascular effects, airway trauma (including the complications of tracheostomy) and barotrauma.

Current favoured modes of ventilation are pressure support ventilation (PSV) and pressure control ventilation (PCV) both with positive end expiratory pressure (PEEP). PS and PCV are probably the modes of choice as they facilitate weaning and limit airway pressures to reduce the risks of volume /barotrauma. Volume control modes are potentially dangerous because the changing lung compliance may lead to dangerously high airway pressures with a high risk of barotrauma. These modes of ventilatory support may be administered via a tracheal tube or by a tight fitting face-mask. Continuous positive airway pressure (CPAP) is essentially PEEP in a spontaneously breathing patient and a relatively recent addition of bi-level positive airway pressure (Bi-PAP) is increasingly popular.

Lung protective ventilation has become common practice in Intensive Care during the 1990s. The principles behind these strategies have been:

- Avoidance of alveolar over distension
- Maintenance of alveolar volume (with titrated levels of PEEP)
- Prevention of the radial stress associated with repetitive re-expansion of lung units at low volumes
- Accepting adequate oxygen levels to meet metabolic requirements
- Accepting permissive hypercapnia

Case of the Month

19 year old train passenger

Pre-Hospital information

(M) Mechanism	Stab left para umbilical region
(I) Injury	Abdomen
(S) Signs	RR 18/m, P 96/m, BP 100mmHg, GCS 15
(T) Treatment	Oxygen, scoop and run, cannula on route

Resus Room

Primary Survey

A Talking
B Breathing ñ Fine
C P 100/mm, BP 105

No external blood loss. Patient alert and co-operative.

Secondary Survey

There is some tenderness and guarding in the region of the stab wound, rest of the abdomen was soft. The stab wound is 1cm in length.

What is your management plan going to be? CT Scan? Diagnostic Peritoneal Lavage? Wound exploration? FAST? Laparotomy? Clinical examination? Laparoscopy?

In the next issue of the Grapevine we will discuss some of the options on what happened to our patient.

Review of last issue's case of the Month

62 year Sheet Metal Worker

Pre-Hospital information

(M)Mechanism	Crushed 500kg press for 20 seconds
(I)Injury	Chest, Abdomen,
(S)Signs	RR 28/m, P 100/m, BP 80 mmHg, GCS 15
(T)Treatment	Oxygen, C Collar, Spinal Protection, IV Fluids 1 L Haemaccel

Resus Room:

Primary Survey

A Talking
B Breathing ñ RR 28/m
Sats 95%
C Pulse 60/m
BP 140/90
No external blood loss. Looked awful!
D Alert GCS 15

Secondary Survey

Laceration to nose
Tender lower right and left rib cage
Upper abdomen mild tenderness
CXR fractured 7th, 8th, 9th right ribs

The plan was to observe and organise a CT abdomen. The patient was a known diabetic and had a previous CABG. At 27 minutes he dropped BP to 100mmHg and Pulse remained at 68/m. A further 500 of Haemaccel was administered and a second episode of hypotension (BP to 98mmHg) occurred at 43min. A FAST examination revealed free fluid in Morrison Pouch and suprapubically. He looked unwell and had significant pain in his lower ribs.

Where to from here?

A difficult decision tree had to be reached between potential intestinal injury which would require immediate surgery or potential hepatic injury which would require probable non-operative management. This is confounded by co-morbidity, diabetes and known coronary artery disease. A decision was made to opt for a CT scan with intravenous and oral contrast. The patient was transported to the CT Scanner and was found to have a small amount of free intraperitoneal fluid, approximately 200 mls, with attenuation coefficient similar to blood. He had a Grade 1 laceration in segment 5 of the liver, small grade 1. There was no splenic injury. There was some thickening of the small bowel. The patient's progress remained haemodynamically stable although his abdominal signs continued to deteriorate with increasing tenderness and some guarding over the site of the crush. In view of the relative minor Grade 1 liver laceration, a diagnostic peritoneal lavage was undertaken to determine if there was small bowel injury. If the diagnostic peritoneal lavage was positive, a laparotomy was going to be done based upon the results of the alkaline phosphatase amylase and white cell count. A diagnostic peritoneal lavage was undertaken. Some 60 minutes later, the results revealed an alkaline phosphatase of 140 (normal value <20 IU/litre) and a white cell count of 1300/^{3}m. At surgery he had perforation to the mid jejunum, mysenteric haematoma, requiring a small bowel resection. His liver laceration received some topical haemostasis. Post operatively his diabetic status was difficult to control requiring a sliding scale. He improved over the next week making a full recovery, and was discharged on Day 9.

This case highlights some of the challenges between operative vs non-operative management. The need to be aware of co-morbidity, the potential for associated intra-abdominal injury (10-15% of such cases have the need to be familiar with the pros and cons of CT scanning, FAST examination and Diagnostic Peritoneal Lavage).

Meetings

Definitive Surgical Trauma Care Course (DSTC) Sydney
(For Surgeons Only)
1st and 2nd August, 2000
*Email:*michael.sugrue@swsahs.nsw.gov.au

SWAN 8

SWAN 8 will be held on the 4th and 5th of August, 2000, bringing to you a number of world leaders in trauma care from overseas. Sorry registration is limited, so get in early!
Contact: Thelma Allen
Email: thelma.allen@swsahs.nsw.gov.au
Phone: 02 9828 3927

What's New in Trauma

Surgical Management of Renal Trauma - Is Vascular Control Necessary?

Introduction

For years, it has been advocated that preliminary vascular control is important prior to exploration of an injured kidney reducing nephrectomy rate blood loss and transfusion requirements. This concept has been challenged by Gonzales and colleagues (Surgical Management of Renal Trauma: Is Vascular Control Necessary. J Trauma 1999: 47;1039-1043) in a study of 56 patients with penetrating renal injuries admitted to a Level 1 Trauma Service. The patients were randomised into preliminary vascular control and no vascular control. The average operating time for vascular control group was longer than for the no control group. Surgery was longer in the vascular control group as was the blood transfusion requirement. They concluded that vascular control of the renal hilum before opening Gerota's fascia has no impact on the nephrectomy rate, transfusion requirement or blood loss. Operative time may in fact increase with the vascular control technique.

Comment

Vascular control is particularly useful where there is a small peri-nephric haematoma in penetrating trauma; but as most patients requiring surgery for renal penetration have large peri-nephric haematomas, a no control method is often quicker and more efficient.

Management of Blunt Pancreatic Injury in Children

Nadler and colleagues from the University of Pittsburg retrospectively reviewed their experience with pancreatic injury in children, to clarify the optimum management strategy. 19 of their patients were managed non-operatively, 32 operatively. They found that patients who had sustained a pancreatic transection had a significantly higher Injury Severity Score, length of stay, had increased serum amylase and lipase than those who had sustained a simple pancreatic contusion. They found that patients who underwent laparotomy within 48 hours of injury for pancreatic transection had significantly shorter length of stay than those with delayed surgery. They recommended early operative intervention for pancreatic transection to help reduce length of stay in complications.

Bedside Insertion of Inferior Vena Cava Filters in the Intensive Care Unit

Sing and colleagues from North Carolina undertook a prospective series of consecutive patients undergoing caval filter insertion in Intensive Care. 32 patients received IVC filters. In their service at the Carolinas Medical Centre, patients categorised as high risk who are unable to undergo prophylaxis with both sequential compression devices and low molecular heparin within 48 hours of admission were considered for prophylactic inferior vena cava filters. Their high risk group included patients with severe head injury, quadraplegia, major pelvic fracture, major lower extremity fracture and repair of a major above the knee (lower extremity vein). In their series they reported one 30 day mortality unrelated to caval insertion. This study identified that IVC caval filters can be inserted safely in ICU with a pre-insertion cavogram, avoiding the risks of transport of critically ill patients.

Lunacy or the Trauma Surgeons Guide to the Lunar Cycle: Make up your own mind.

Praba and colleagues from Ohio State University undertook a study to determine if the lunar cycle really does influence our fate or whether we should be consulting the Farmer's Almanac to plan our trauma call schedules? They evaluated five years admission to a Level 1 Trauma Service, identifying full and new moons. During the five year period, 500 patients were admitted to their trauma service during a full moon and 480 during the new moon. Full moon trauma was associated with a significantly higher mortality Injury Severity Score and a higher instance of motor vehicle crashes and a higher incidence of burns on a new moon day. They found in their study significantly increased mortality in morbidity and ISS associated with the full moon supporting the centuries old suspicion that the lunar cycle may indeed influence human behaviour.

Comment:

Make up your own mind. Review their abstract in J Trauma January 2000: Vol 48; 196.

Functional regeneration of sensory axons into the adult spinal cord

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The arrest of dorsal root axonal regeneration at the transitional zone between the peripheral and central nervous system has been repeatedly described since the early twentieth century. Here we show that, with trophic support to damaged sensory axons, this regenerative barrier is surmountable. In adult rates with injured dorsal roots, treatment with nerve growth factor (NGF), neurotrophin-3 (NT3) and glial-cell-line-derived neurotrophic factor (GDNF), but not brain-derived neurotrophic factor (BDNF), resulted in selective regrowth of damaged axons across the dorsal root entry zone and into the spinal cord. Dorsal horn neurons were found to be synaptically driven by peripheral nerve stimulation in rats treated with NGF, NT3 and GDNF, demonstrating functional reconnection. In behavioural studies, rats treated with NGF and GDNF recovered sensitivity to noxious heat and pressure. The observed effects of neurotrophic factors corresponded to their known actions on distinct subpopulations of sensory neurons. Neurotrophic factor treatment may thus serve as a viable treatment in promoting recovery from root avulsion injuries.

PS. MS Ramer is Sarah Ramer's brother. A Traumatic Family!

Consensus within a large body of Critical Care has lead to the recommendations that:

- Inspiratory plateau pressure be limited to <35 cm H_2O (or maximum trans-alveolar pressure to <25-30 cm H_2O)

Independent lung ventilation using a double lumen tube is occasionally used to treat severe unilateral contusions, protecting the good lung from the adverse effects of artificial ventilation. Refractory hypoxaemia has been managed with extracorporeal membrane oxygenation (ECMO), extracorporeal CO_2 removal ($ECCO_2R$) and intravascular oxygenation (IVOX) but the role of these therapies is yet to be defined and they are limited to investigating centres.

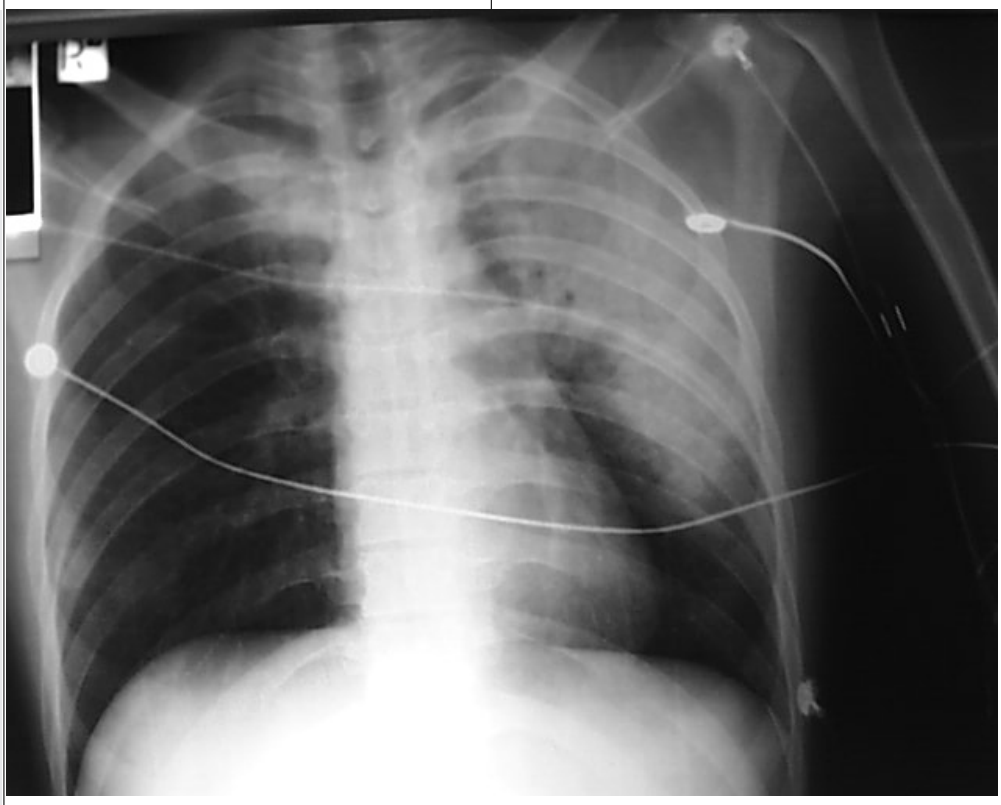
FURTHER MANAGEMENT INCLUDES:

- Analgesia. Adequate analgesia is a major determinant of effective ventilation and clearance of secretions. IV opioids are most commonly used but potential sedation and respiratory depression are risks. Regional nerve blockade with an epidural catheter provides high quality analgesia without sedation and is probably the technique of choice (intercostal nerve blocks and intrapleural local anaesthesia are less reliable.) NSAIDs are often used as adjunctive analgesia (reducing the requirement for opioids) in the early stages and as sole analgesia after a few days.
- Physiotherapy and bronchodilators to enhance pulmonary toilet and avoid sputum retention.
- Fluid management. Exemplifies the requirement for careful monitoring. There is no scientific support for the notion of "running patients with pulmonary trauma dry" (ie. hypovolaemic) in order to prevent increased extravascular lung water.
- Excluding other significant injury. Anecdotal experience suggests there is potential to miss or delay the diagnosis of ruptured aorta, ruptured diaphragm, myocardial contusion and spinal injury.
- Nutritional support
- Thromboprophylaxis

OUTCOME

There are few outcome studies to assess. Factors strongly associated with mortality include age, oxygenation ratio at 24 hours and volume of resuscitation fluid. Mortality rates of 37.5% for patients >60 years old and 22.8% for all groups requiring mechanical ventilation have been quoted. Also a mortality rate of 16% for patients with pulmonary contusion increasing to 42% if there is a significant flail chest have been published but these are figures come from the 1980s and are unlikely to be representative today.

Figure 1. Extensive left sided pulmonary contusion following high-speed frontal impact car crash. Note the lack of obvious rib fractures in a compliant young chest. Ventilation was assisted in Intensive Care with non-invasive mask CPAP and morphine PCA.



SUMMARY

Not surprisingly, no single strategy will apply to all patients. Individual assessment and management of patients with pulmonary contusion should be in a High Dependency Unit / Intensive Care Unit facility. Ventilatory strategy will be determined by a number of factors including severity of the chest injury, pre-existing pathology, the effectiveness of analgesia and other injuries. As with all clinical interventions it is a matter of balancing the risks and benefits. Many patients with pulmonary contusions will benefit from mechanical ventilatory support and survive to make a full recovery.

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Blood Transfusio in Critically Ill T

What is th

Sarah Ramer, University of Calgary

Blood transfusion is a cornerstone of management of the critically ill trauma patient. The efficacy of blood transfusion in improving survival of the trauma patient with severe to massive or ongoing blood loss is indesputable[1,2]. Moreover, survival rates post massive transfusion have been shown to have improved significantly over the past ten years due to a number of factors, including better blood product warming techniques and more aggressive correction of coagulopathy[2]. In another category of trauma patient, however, are those whose haemorrhage is controlled and who have haemoglobin levels which are stable in the range of 70-100 g/L. Is there a need to transfuse in this subgroup of patients? In scenarios such as this the risks of anaemia must be weighed carefully against the potential benefit (and potential risk) of blood transfusion.

Over the past several years there has been an increasing awareness within the medical community of the risks associated with blood transfusion.

The foremost in the media, certainly, is the risk of transmission of diseases such as HIV and Hepatitis C. There are, however many other recognised short term and long term complications of transfusion in trauma patients, including electrolyte abnormalities, coagulopathy, bacterial infection[3] and multi organ failure[4]. An increased awareness of the risks of transfusion has been one factor that has driven a marked reduction in the frequency of blood transfusions among critically ill patients[5], including trauma patients[6]. Improved cell-saver technology has probably also been a factor. Despite this reduction, however, at least one recent study has shown that many transfusions in the critical care setting are administered because of an arbitrary transfusion trigger rather than by a true physiologic need for blood[7].

What degree of anaemia can the trauma patient safely tolerate? Several recent studies have looked at various aspects of this question in critically ill patients[8-14], of which trauma patients are a subgroup. Older studies have recommended a liberal strategy of transfusion (in which patients are transfused when their haemoglobin levels drop below 100 g/L) in improving survival in the critical care setting[11, 12]. More recent research, however, has recommended a more restrictive approach[8,13]. The most noted of these studies is a multicentre, randomised controlled clinical trial which was published in the New England Journal of Medicine in 1999[8]. This study concludes that a restrictive strategy of red-cell transfusion (in which red cells were transfused only if haemoglobin levels drop below 70 g/L) is at least as effective and possibly superior to a liberal transfusion strategy (in which transfusion was given to patients whose haemoglobin drops below 100 g/L). A subgroup analysis of trauma patients (n=100 in each of the two study groups) showed no significant difference in mortality between restrictive and liberal transfusion practices (30 day mortality 10.0% and 8.8%, respectively p=0.81). Of note, however, trauma patients who were hypovolemic or who had ongoing blood losses were excluded from this study.

The efficacy of restrictive transfusion protocols in subgroups of critically ill patients who have cardiac disease or who are older than 55 years of age remains controversial. Some research has shown that mild to moderate anaemia increases the risk of death after surgery in critically ill patients with cardiac disease[9,10], and thus a more liberal transfusion strategy has historically been recommended for this subgroup. It has also been suggested in at least one study that critically ill surgical patients 50-75 years of age demonstrate significantly improved survival rates with increased oxygen delivery (by any of transfusion, fluids or vasoactive agents)[14]. Subgroup analysis of the more recent research, however, indicates no significant difference in mortality of critically ill patients >55 years of age, or in those with cardiac disease when a restrictive transfusion approach is compared to a more liberal strategy[8].

Trauma patients are a unique group whose blood requirements differ from many critically ill patients because of the acute nature of their blood loss, the fact that they frequently require multiple operations, and in meeting the oxygen delivery demands of their extremely high metabolic rates during recovery. Though there has been shown to

Comment

Sarah Ramer provides us with an interesting review of the use of RBC transfusion in critically ill trauma patients. Haemorrhage in trauma reduces oxygen carrying capacity. The primary aim of transfusion is to restore oxygen carrying capacity. However many trauma patients are able to compensate by increasing oxygen delivery through increasing cardiac output. However patients with a fixed cardiac output or significant coronary artery disease may be unable to compensate in this manner. Identifying these and other patients who have a clear benefit from transfusion is not always easy. There are clear and well-documented risks associated with transfusion but conversely optimal or safe lower limits for haemoglobin levels have not been established in critically ill trauma patients.

Techniques to reduce the need for transfusion, increase blood conservation and alternatives to human red blood cells may eventually render blood transfusion obsolete. However, what should those of us involved in trauma patient care today be doing?

We should make surgical (or non-surgical) haemostatsis the top priority for patients who are actively bleeding. Subsequent

on Requirements
Trauma Patients:
e evidence?

Calgary, Alberta, CANADA February 2000

be no significant difference in mortality between restrictive and liberal transfusion practices in trauma patients in the critical care setting[8], a larger cohort of trauma patients may be required in order to effectively study this unique group. Newer technologies in blood substitutes will also require further study, as these will undoubtedly have a huge impact on the practice of blood transfusion in trauma worldwide. Encouraging results have recently been reported with HbOC-201, a Hb based oxygen carrier.[15]

Until further trials are completed, liberal blood transfusion must still be considered the 'gold standard' in comprehensive management of the critically ill trauma patient. Current literature supports a restrictive transfusion protocol (transfuse when Hb <70 g/L) as a safe alternative to a liberal protocol (transfuse when Hb <100 g/L) in only those patients who are euvolemic, not actively bleeding, have no cardiac disease, and are under the age of 55.

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(Sarah Ramen was a Visiting Trauma medical student at Liverpool Hospital)

management should aim to avoid further blood loss by maintaining normothermia, adequate clotting and platelet function while avoiding excessive blood sampling or procedures with a high risk of blood loss. Anaemia is much better tolerated than hypovolaemia, a fact that is regularly seen in the peri-operative management of Jehovah's Witnesses. As with all interventions in medicine the risk benefit must be assessed on an individual patient basis. Continuous monitoring and repeated evaluation of the patient, tissue oxygenation and metabolic status will guide the rational use of RBC transfusion and identify patients in whom low haemoglobin levels (the Hebert study suggests values of 7-9g/dl) are adequate to meet oxygen requirements. Patients with fixed cardiac outputs, acute MI or unstable angina are high-risk groups where the benefits of more liberal transfusion outweigh the risks.

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