The Paediatric Transfusion Challenge on Deployed Operations

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Abstract

This paper briefly touches on the problem of dealing with the severely injured child requiring massive transfusion and produces a guide on the management of this based on the current Surgeon General's Operational Policy Letter. There are no known UK guidelines on massive transfusion in trauma in the paediatric population although many specialist centres have guidance for dealing with cases in theatre during elective surgery. It is hoped that these guidelines will be used by deployed military anaesthetists to aid in their management of these difficult cases, not normally seen in the UK.

Introduction

The last few years have proved a busy time for the Defence Medical Services (DMS) in terms of operational commitments and the development of military medical techniques. War fighting has historically provided a rich environment for the advance of medical care including blood transfusion, antibiotics, wound care and casualty retrieval to name but a few. The recent conflicts have proved no exception with major advances in blood product therapy, a refining of damage control resuscitation techniques, from the early extraction of casualties, through to rapid damage control time-limited surgery and the rapid evacuation back to UK Role 4 through our Critical Care Air Support Team (CCAST) capabilities.

Much attention and energy has been directed towards improving the lot for our injured troops with a perceived improvement in outcome. An unfortunate but inevitable outcome of the current war fighting is the presence of casualties amongst the paediatric population. The causes for this are varied, but include legacy munitions, enemy and coalition activities, as well as ongoing domestic accidents. The UK military has traditionally treated all those appearing at our medical facilities according to an eligibility matrix whose interpretation can vary depending on tempo of ops and state of medical facilities. Irrespective of this, it is incumbent on UK medical personnel to provide the best quality care possible to those admitted to our Role 2 and 3 medical facilities. This is not always straightforward nor is it a purely medical decision. Very difficult ethical and logistic dilemmas can arise, which must be looked at on an individual basis.

Paediatric Anaesthesia and Critical Care Special Interest Group

The challenge of paediatric patients in the military environment is now accepted across the DMS and appropriate provision is being undertaken to provide the equipment to deal with this situation. As part of this process, the Defence Consultant Adviser (DCA) in Anaesthetics has commissioned the formation of the Paediatric Anaesthesia and Critical Care Special Interest Group (PACCSIG). The PACCSIG consists of four consultant anaesthetists (one an intensive care specialist), two trainees and a nurse with a sub speciality interest in paediatric issues across the board. It meets twice a year and has the following remit:

1. Examine equipment issues, staff training and standards of care where anaesthetists may be involved in the care of children including pre-hospital care, ED, theatres, ICU, wards and transfer.
2. Outputs to include annual module review for the anaesthetic specialist interest group
3. Production of an annual activity report to the DCA.

Minutes of PACCSIG proceedings are sent to DCA's in all relevant disciplines and it is hoped that it will act as a focus for paediatric issues throughout the DMS.

Workload

Current paediatric workload is still to be determined but some raw data has been retrieved. For the purpose of looking at paediatric casualties in both Iraq and Afghanistan a request was put in to the Joint Theatre Trauma Registry (JTTR) at Birmingham to obtain data on all children treated under the age of 16 from March 2003 to August 2009. On Op TELIC (Iraq) 29/271 (4%) of admissions were children compared to 147/1769 (8%) for Op HERRICK (Afghanistan). The age and gender of the children admitted are given in Figures 1 and 2.

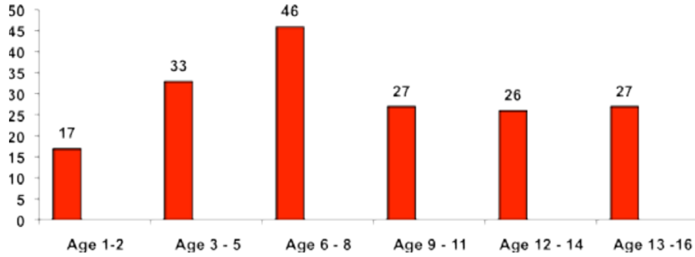

Figure 1. Age Breakdown of Paediatric admissions

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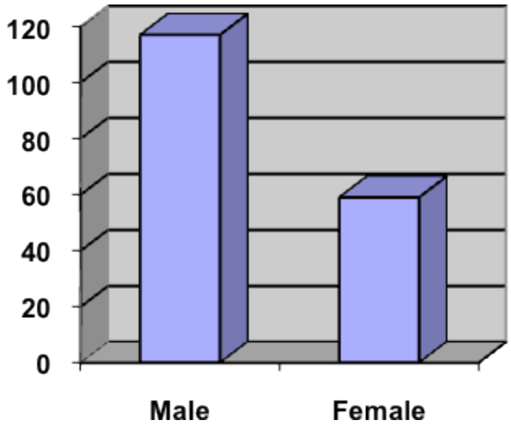


Figure 2 Gender Breakdown

A review of US data has recorded 10% of all admissions to their Combat Support Hospital (CASH) facilities in Iraq and Afghanistan as paediatric, with penetrating injuries accounting for three quarters of cases [1].

This correlates well with data collected from Herrick 8B/9A [2] where 10.1% of all surgical operations within the UK Med facility were carried out in children and one third of all the paediatric surgical population were admitted to the ICU, which comprised 11.9% of the total ICU admission load. These figures do not necessarily reflect the real contribution of paediatric casualties to ICU work. Coalition casualties are generally evacuated to the UK within 24 hours, whereas paediatric ICU admissions may spend a protracted period on the intensive care unit.

A review by Gurney in 2004 [3] looked at activity in the UK surgical field hospital during the war fighting phase of the TELIC 1 campaign and quoted paediatric patients as comprising 2.9% of all recorded admissions. This figure is lower than others have experienced on previous campaigns and may be a reflection of the relatively peaceful period which was in place prior to the sustained insurgency campaign when kinetic activity ie the- use of munitions and firearms, escalated considerably, often in an indiscriminate manner or directly targeting the civilian population This small figure of 2.9% has the potential to be slightly misleading as children accounted for nearly a third of all non-coalition patients, a figure which may need to be borne in mind when planning medical aspects of future operations.

Present military operations in Afghanistan are generating a large number of fragmentation and gunshot wounds (GSW). Harris and McNicholas [4] in this journal reviewed the paediatric workload on Critical Care with 15 admissions over two months in mid-2008. Mechanism of injury was predominantly penetrating GSW or fragmentation (absolute numbers not given) and a mean age of six years (range 6 months to 17 years) was recorded. This population was a significant part of the Critical Care workload with a paediatric admission present for 66% of the time and accounting for 30% of all bed occupancy.

PACCSIG continues to retrieve data, but it is clear that the challenge of paediatric admissions is impacting significantly on field hospital resources and must be taken into account when planning personnel, equipment and patient disposal. The current matrix of Medical Rules for Eligibility (MRE) ensures that the hospital front door is open for many of the civilian population at risk (PAR). Whilst considerable effort is being devoted to the development of local medical facilities, the reality is that they are a long way from providing critical care of a standard comparable to the joint UK/US hospital in Helmand.

Massive Transfusion in Trauma

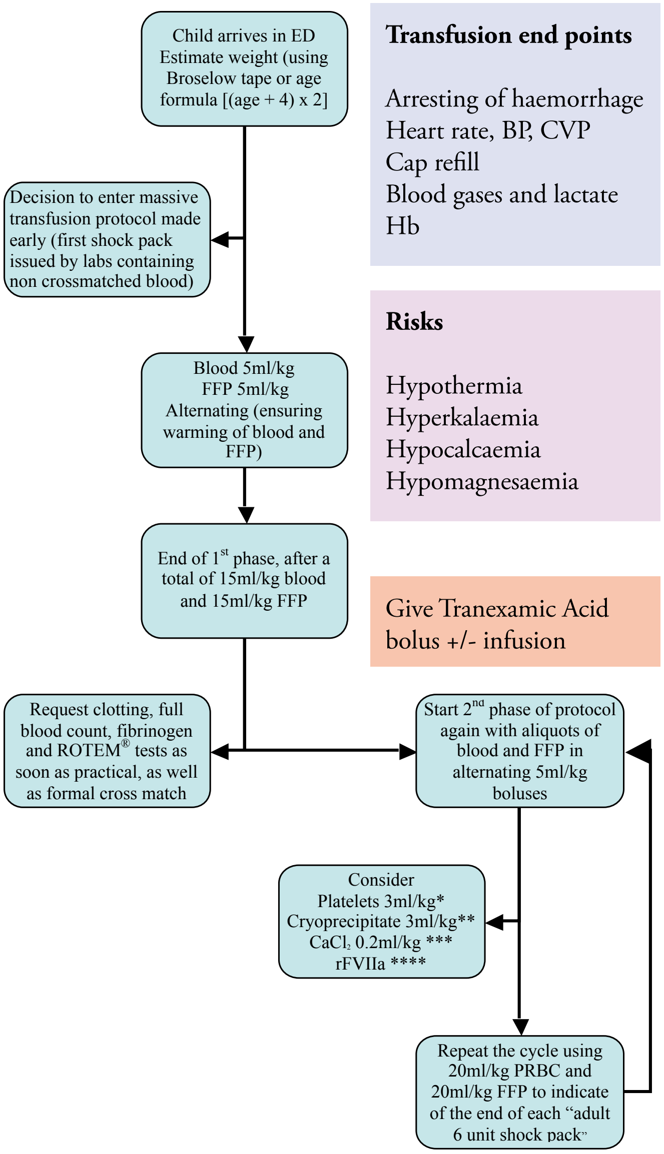
The Surgeon Generals Operational Policy Letter (SGPL) on massive transfusion [5] updated the most recent advice on the management of major haemorrhage on operations. This is an adult based guideline which has developed extensively over the past few years and is still part of the ongoing evolution of trauma transfusion medicine. The Association of Anaesthetists of Great Britain and Ireland (AAGBI) is in the process of generating a document on this subject and will include a section on the management of paediatric massive transfusion. As part of the process some of the authors of this article in conjunction with the PACCSIG have developed a simple guideline based on reverse engineering of the adult SGPL. This has been carried out to provide a protocol on which to base a weight guided massive transfusion for situations where major haemorrhage is a problem in children. It enables physicians to guide paediatric patient resuscitation with greater confidence, and is intended to be used in conjunction with the clinical monitoring and near patient testing already available.

The adult protocol dictates that on arrival in the ED, laboratory staff will provide 4 units of O negative packed red blood cells (PRBC) and 4 units of Fresh Frozen Plasma (FFP) for initial resuscitation in the massive transfusion case although a trend towards 2 unit packs of FFP and blood is now developing and may certainly be more appropriate for paediatric resuscuation. This constitutes the first phase. The second phase is entered when the lab issues the second major haemorrhage pack consisting of 6 units of cross matched PRBC and 6 units of FFP.

As a practical guide to the laboratory and the resuscitation teams we recommend the following guide (Figure 3) be used with reference to the key points in Table 1, to ensure appropriate fluid therapy and efficient use of blood products.

- In the first phase, order 1 unit (U) of PRBC and 1 U of FFP for every 20kg weight of the child, e.g. a 23kg child will need 2 U blood and 2 U FFP initially. This will ensure a minimum of approximately 15 ml/kg, i.e. approx 300ml each of FFP and PRBC for a 20kg child.
- A bag of PRBC or FFP for an adult is equivalent to approximately 4ml/kg for the child.
- Alternate boluses of PRBC and FFP are given in a volume of 5ml/kg.
- The first phase of transfusion for an adult, 4 U of PRBC and 4 U of FFP, is equivalent to approximately 15 ml/kg (3 boluses) of each product for the child.
- Use all clinical signs to help guide resuscitation, including arterial wave form, central venous pressure, blood pressure and urine output, as well as laboratory results, particularly arterial blood gases and rotational thromboelastometry ROTEM® (TEM Innovations GmBH, Munich Germany).
- Order more PRBC/FFP as required. (remember bool can be returned to labs within 30 minutes if cold box unopened)
- Platelets should be given at 3ml/kg, however ROTEM® may indicate a requirement for more platelet transfusion. SGPL guideline aims for platelet count above 100 x 109/l.
- The dose for Calcium Chloride is 0.2ml/kg.
- The dose for Tranexamic Acid is 15mg/kg bolus, followed by an infusion of 1mg/kg/hr.

Table 1 Paediatric Massive Haemorrhage Key Points



consider transfusing whole bag if platelets required and volume not an issue; ** aim for fibrinogen above 1g/l; * Aim for ionised Ca above 1mmol/l; ****1 Dose of 100mcg/kg repeated after 20 minutes if necessary. Aim for as near normal physiology as possible pre administration*

Fig 3. Framework for Paediatric Massive transfusion based on SGPL

Paediatric Massive Haemorrhage: Practicalities of Resuscitation

The practicalities of this process are not as straightforward as for adult transfusion and a system for delivering the blood products must be assembled and rehearsed with all staff who may be involved in this process. There may be several "rigs" which staff may have used within different hospitals and but it is recommended one single assembly is agreed amongst deployed clinical staff to promote familiarity and minimise risk of mishaps.

Practical points to be considered during major haemorrhage management in the paediatric population include the following:

- Invasive pressure monitoring is essential.
- Large bore central venous access is ideal. Multiple peripheral cannulae may not be possible and lead to the risk of multiple "ectopic" fluid transfusions.
- A fluid warmer is essential.
- The ability to deliver air free warmed boluses of blood products and fluids is an important practical issue. A set up such as the one described below can be used successfully, but teams need to be briefed and trained in its safe use before the event.
  - At the proximal end of the fluid warmer 4 three way taps should be attached in series to 4 bags of fluid and their giving sets. The 4 bags may contain any of the following; crystalloid, colloid, blood and FFP. At the distal end of the fluid warmer a further 2 three way taps should be attached in series. One for a 50 ml syringe to use as the main 'pump' to use for each fluid bolus and a further tap for the addition of drugs. Distal to this should be a short connector to the central line. This connector should be secured in some manner to the bed so it takes the weight of the 50ml syringe and lines. This approach has been used to good effect in the ICU during the current phase of Op HERRICK. It shoud be borne in mind that with the Level 1 Infusor (Smiths Medical Level 1® H-1200 Fast Flow Fluid Warmer) currently in use in rhe British military there is a potentially significant dead space of up to 60 mls from the upstream to the down stream locations of the warming element. This will become increasingly important for the smaller child and alternative arrangements should be explored in these circumstances.
  - The physical arrangement described will provide an accurate method of administering specific volumes of the required fluid. Fluid will be warmed and speed of administration controlled by hand. Drugs can be given without interruption of transfusion.
- It is vital to record the volumes given with accuracy. Ideally these should be recorded concurrently and in a location which all can see (e.g. wipe board).
- Platelets should be given through a different giving set to a different line and consideration should be given to transfusing the whole bag on the basis that our recommended 3ml/kg is reasonably conservative and once issued this scarce resource needs to be utilised efficiently.

Management of major haemorrhage is often an obvious clinical picture in the emergency room and the operating theatre but it may also require recognition and initiation in other areas within the hospital and useful definition of massive transfusion in the paediatric population is given in Table 2 to aid in this aspect, particularly with respect to ongoing blood loss

- Replacement of 1 blood volume in 24 hours
- 10 units of Red Cells in 24 hours (40ml/kg)
- 4 units in 1 hour (16ml/kg)
- Replacement or loss of50% blood volume in 3 hours
- Rate of blood loss >150ml/min (2ml/kg/min)

Table 2: Definition of Massive Transfusion (proposed paediatric figures in brackets)

Valuable lessons can be gained from observing treatment of massive haemorrhage and coagulopathy in children undergoing elective surgery in UK specialist paediatric hospitals. Procedures such as hepatic transplantation, scoliosis surgery and cranio-facial surgery are examples of practice in which important anaesthetic experience can be gained, not only in the practicalities of resuscitation of massive haemorrhage and coagulopathy, but also in logistics of how the volumes can be transfused. It is the opinion of the PACCSIG that military paediatric anaesthetists should have regular exposure to this experience or attend refresher training in a specialist paediatric unit prior to deploying.

Conclusions

This paper describes a guide for resuscitation in paediatric massive haemorrhage to be used by deployed anaesthetists in Afghanistan. It should be used in addition to conventional clinical signs and monitoring, including near patient laboratory investigations.

Although not forming our core work on military operations the challenge of the injured and sick child is real and something that we face weekly on current deployed operations. It is important that we provide a well trained cadre with an appropriate skill mix, in order to deal with the full spectrum of clinical cases including children. Improved awareness and delivery of first class care to children will lead to both a better outcome for the injured child and a more efficient use of limited hospital resources.

Further work is being undertaken with the PACCSIG across a whole range of paediatric deployed issues and covering aspects of daily care, training and audit of outcome. It is hoped that the authors can communicate developments through this journal as our work proceeds.

Acknowledgments

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