REVIEW

MILITARY INTENSIVE CARE PART 3. FUTURE DIRECTIONS

JD Henning[1], A Mellor[2], A Hoffman[3], PF Mahoney[4]

[1]Intensive Care Unit MDHU (Northallerton), [2]Cardiac Anaesthesia MDHU (Northallerton), [3]Critical Care, Royal Navy, [4]Royal College of Defence Medicine

Introduction

Over the past few years there have been significant advances in Intensive Care Medicine including new drugs and technologies. It is essential that developments which may have relevance to military practice are continually reviewed and adopted where appropriate and practical in the deployed environment.

New drugs

The issue with all new drugs is balancing perceived benefits against potential side effects.

Activated Protein C

Activated Protein C has been shown to decrease mortality in sepsis [1]. It would seem to be most beneficial in a select group of patients (those with mid range APACHE scores). Sepsis is not a common presentation to a deployed field hospital, where the main patient group has suffered from major trauma, and tends to be evacuated within 48 hours. However, longer stays are more common amongst foreign nationals where the evacuation chain is often less clear or the possibility may not even be available. One of the side effects of APC is cerebral haemorrhage which would be a devastating complication in a young soldier. However on occasion the deployed Intensive Care Unit must be prepared to accept patients for longer periods when the evacuation chain is prolonged.

Procalcitonin

Procalcitonin has shown some promise as a blood test to diagnosing sepsis, but is best validated in children, it may of use if the test translates into the field environment [2].

Haemostatic issues

Haemostatic issues and rFVIIa are dealt with elsewhere in this journal.

Fluid Regimes

Hypertonic Saline may offer a useful alternative to both mannitol and colloids. It has been shown to effectively raise blood pressure in the shocked patient, and decrease intracranial pressure in head injured patients. It may also have beneficial effects in the modulation of the stress response to injury and decrease the incidence of ARDS. Work is ongoing at RCDM and James Cook University Hospital to assess the role of hypertonic fluids in UK military practice.

New Protocols

Care Bundles

A critical ill patient will continue to be exposed to further insults during their care. For example a ventilated patient is at risk of developing gastric stress ulcers, ventilator associated pneumonia and ARDS, all of which can lead to Multi Organ Dysfunction Syndrome (MODS). Many units have developed care bundles to ensure these are minimised (For example, the ventilator care bundle will generally consist of acid prophylaxis, head up nursing, early feeding and small volume tidal ventilation).

Small volume Tidal Breaths (7ml/kg vs 12ml/kg), with a high level of PEEP to maintain oxygenation has been shown to decrease the incidence of ARDS. This requires accepting a higher than normal CO_2 and a resulting respiratory acidosis [3].

Early enteral feeding has also been shown to improve outcome in critically ill patients, not least from a reduction in the incidence of nosocomial pneumonias and gastric stress ulceration. Strategies to ensure this happens have been developed on most civilian ITUs. Alongside this, recent work has shown that tight glycaemic control decreases mortality, but the patient populations in these studies do not mirror those on field ITUs [4].

Since 2004, many civilian units have implemented the 'surviving sepsis' campaign care bundle. This details seven tasks which need to be implemented within 6 hours of diagnosing a patient with severe sepsis, and a further four management goals [5]. This needs to be adopted within the military field hospital.

New technology

Traditionally ITUs have used invasive monitoring and ventilation as the mainstays of therapy. There are emerging technologies, and new ways of using old technologies which may prove to be of benefit.

Seven Tasks

- Measure serum lactate
- Obtain blood cultures before antibiotics are given
- Improve time to broad spectrum antibiotics
- Treat hypotension and/or elevated lactate with fluids
- Treat ongoing hypotension with vasopressors
- Maintain an adequate central venous pressure
- Maintain an adequate central venous oxygen saturation

Four management goals

- Administer low dose steroids by a standard policy
- Administer drotrecogin alpha (activated recombinant protein C) by a standard policy
- Maintain adequate glycaemic control
- Prevent excessive inspiratory plateau pressures

Figure 1: Management of sepsis

Monitoring

Cardiac Output (CO) monitoring using a Swann Ganz catheter was extensively used in the early 1990's on critically ill patients, but use declined when a study showed an excess of mortality in the group of patients in whom it was used. Since then other studies have shown no benefit from the use of cardiac output monitoring when used for all intensive care patients [6] but there may be sub- groups of patients in whom cardiac output monitoring is desirable. In the last few years newer less invasive

monitors have entered the market. Transoesphageal echocardiography (TOE) enables accurate visualisation of the heart and great vessels. Pictures are achieved in real time and the use of TOE has been advocated to guide fluid resuscitation [7,8]

Ultrasound

Ultrasound generally is a modality that is becoming much more widespread in use. NICE guidance is that US should be used for neck line insertion in elective patients and should be available in for emergency insertions [9]. In addition to vascular access, the use of ultrasound will undoubtedly expand to include peripheral nerve blocks and scanning for pleural effusions. Currently small and portable US machines are available in deployed hospitals but these are not specific vascular access machines. Importantly over a period of time the medical staff deployed will have had more use of ultrasound and less of traditional "landmark" techniques in their civilian practice making the availability of ultrasound in deployed ICU's imperative.

Figure 2: Bedside ultrasound

Figure 3: Hand held ultrasound

Treatment

Renal

Continuous veno-venous haemofiltration is used to provide temporary renal support for failing kidneys Reasons for using renal replacement therapy include removal of inflammatory mediators in sepsis and clearing ingested toxins [10]. Military field ITU's at present do not carry the necessary equipment, as the machines in the past have been cumbersome and required a large volumes of fluid (with resulting logistical problems). The newer machines are smaller, require less fluid and are more user friendly. They may have a place in the field, but there are training and logistic implications when introducing a new capability. The field ITU also has to be prepared to treat civilian patients, who may stay for a long time if there is no evacuation strategy for them, and may develop renal failure.

Ventilation

Non Invasive Ventilation (NIV) is becoming more popular and has been shown to decrease ITU stay in some groups of patients [11] Continuous Positive Airway Pressure (CPAP) has been used for years as an intermediate step to prevent the need for IPPV, but has, in the past, required a high pressure, high flow oxygen system to run it. This has always been logistically impossible in the field ITU, but the recently developed Boussignac system provides the same CPAP using less pressurised gas [12, 13].

Percutaneous Tracheostomy

Tracheostomy may be required at an early stage (for example, in severe facial injuries as a means of airway management) or later to aid weaning from a ventilator. Tracheostomy may also help reduce the length of ITU stay for trauma patients [14]. In many civilian ITUs this is now performed by the intensivist percutaneously [15] and ideally under bronchoscopic control [16] The British Thoracic Society recommends that *"all ITU's should have the facility to perform urgent and timely flexible bronchoscopy for a range of diagnostic indications"* [17] However there are problems with providing bronchoscopy in a field environment which chiefly relate to the effective cleaning of the fibre optic scopes.

Figure 4: Percutaneous tracheostomy equipment

Figure 5: Percutaneous tracheostomy insertion

ICP monitoring

Invasive Intracranial pressure (ICP) monitors have been used on neuro-intensive care units in head injured patients for many years. Although there are no quality RCTs showing conclusive benefit, they have become a standard of care (many would argue a RCT would now be ethically impossible to perform). Recently a report has shown that morbidity is improved if a head injured patient is treated on a neuro intensive care unit (whether they need surgery or not) [18] and a case matched control study is ongoing to find out why this might be. Early indications suggest it may be the maintenance of cerebral perfusion pressure. [19] As there is data to show that the incidence of adverse events from inserting this monitoring equipment is minimal, and it has been used safely in regional DGHs [20] it should be safe to use in the field, especially once a tier 2, portacabin type unit has been established. However it is clear that it is not the monitor itself which makes the difference, therefore all military intensivists and ITU nurses will need significant neuro ITU experience.

Data collection

Many Intensive Care Units in the UK subscribe to the Intensive Care National Audit Research Centre (ICNARC) Case Mix Programme (CMP). This provides useful information to the units about case mix and mortality. In addition it adds a quality control element as mortality between units can be measured. Nationally it provides useful audit research information [21] At present there is no central database for recording ITU admissions to field units.

Communications

Improved communication, e-mail and telemedicine mean that deployed doctors are no longer isolated. If comprehensive guidelines are produced and backed up with a robust system for obtaining immediate advice, it should be acceptable for small field ITUs (possibly defined as less than 4 beds with an occupancy of less that 50% level 3 patients) to be covered by those with appropriate practical skills (for example intubation, central venous cannulation), but no regular intensive care commitment. This is not unlike the situation in rural USA and Australia where the governance issues have been addressed using real time, video telemedicine [22].

Training

Intensive Care Medicine is now a subspecialty recognised by PMETB. Increasingly, no new consultant appointments in the NHS with ITU commitments are given to those without specific ITU training. At present this would be unsustainable within the UK military – there are simply not enough appropriately qualified people to provide this. However a cadre needs to be recognised, which can provide advice and develop protocols. This needs to be multi disciplinary as doctors in specialities outside anaesthesia are training to become intensivists.

Every anaesthetist deploying to operations must be encouraged to attend a HOSPEX. This is a unique exercise, where multiple simulators are used to provide collective training over 3 days. This promotes team building and also provides exposure to the equipment used in Field Intensive Care Units.

Equally the cadre of ITU nurses needs to expand, and their work in the UK needs to reflect operational practice. They must have frequent exposure to the multiply injured patient.

The future

DMS delivers high quality ICU to deployed UK Forces, coalition partners and civilian patients. To maintain this quality it is vital that DMS remains aware of new techniques and equipment that may have a place in the field. Further development of DMS deployed ITU capability requires robust data collection, audit, research and close cooperation with the NHS ITU community. These will be core functions of the Critical Care working group of the Department of Military Anaesthesia and Critical Care.

References

1. Bernard RG, Vincent JL, Laterre P et al. Efficacy and safety of recombinant human activated protein C for severe sepsis. *New England Journal of Medicine* 2001; **344:** 699-709
2. Uzzan B, Cohen R, Nicolas P, Cucherat M, Perret GY.Procalcitonin as a diagnostic test for sepsis in critically ill adults and after surgery or trauma: a systematic review and meta analysis. *Crit Care Med.* 2006; **34(7)**:1996-2003
3. The Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome. *New England Journal of Medicine* 2000; **342:** 1301.
4. Van den Berge G, Wouters P, Weekes F et al. Intensive insulin therapy in critically ill patients. *New England Journal of Medicine* 2001; **345:** 1359-1367.
5. Dellinger R, Carlet J, Masur H et al for the Survivng Sepsis Management Guidelines Committee Surviving sepsis campaign guidelines for management of severe sepsis and septic shock. *Crit Care Med.* 2004; **32(3):** 858-873
6. Harvey S, Harrison DA, Singer M, Ashcroft J, Jones CM, Elbourne D, Brampton W, Williams D, Young D, Rowan K, on behalf of the PAC-Man study collaboration. Assessment of the clinical effectiveness of pulmonary artery catheters in management of patients in intensive care (PAC-Man): a randomised controlled trial. *Lancet* 2005; **366:** 472-77.
7. Burns JM, Sing RF, Mostafa G, Huynh TT, Jacobs DG, Miles WS, Thomason MH. The role of transesophageal echocardiography in optimizing resuscitation in acutely injured patients. *J Trauma.* 2005 Jul; **59(1):** 36-40; discussion 40-2.
8. Hoole SP, Falter F. Evaluation of hypoxemic patients with transesophageal echocardiography. *Crit Care Med.* 2007 Aug; **35(8 Suppl):** S408-13
9. NICE Guidance number 49, September 2002.
10. Kishen R, Blakeley S, Bray K,Renal Replacement Therapy: *Intensive Care Society(Draft)* 2007.
11. Crummy F, Naughton MT Non – Invasive positive pressure ventilation for acute respiratory failure: justified or just hot air?. *Intern Med J.* 2007 Feb; **37(2):** 112-8
12. Vitaid ltd. www.vitaid.com
13. Moritz F, Benichou J, Vanheste M, Richard JC, Line S, Hellot MF, Bonmarchand G, Muller JM. Boussignac continuous positive airway pressure device in the emergency care of acute cardiogenic pulmonary oedema: a randomized pilot study. *Eur J Emerg Med.* 2003 Sep; **10(3):** 204-8.
14 Arab Y, Samir Haddad S, Shirawi N Al Shimemeri A.Early tracheostomy in intensive care trauma patients improves resource utilization: *a cohort study and literature review Critical Care* 2004, **8:** R347-R352.
15. Friedman Y, Fildes J, Mizock B, Samuel J, Patel S, Appavu S, Roberts R.Comparison of percutaneous and surgical tracheostomies. *Chest.* 1996 Aug; **110(2):** 480-5.
16 Barba CA, Angood PB, Kauder DR et al. Bronchoscopic guidance makes percutaneous tracheostomy a safe, cost effective and easy to teach procedure. *Surgery* 1995; **118:** 879-83
17. BTS guidelines on flexible diagnostic bronchoscopy Thorax 2001; **56:** (Suppl 1):1-21
18. Patel HC et al, on behalf of the Trauma Audit and Research Network Trends in Head Injury outcome from 1989 to 2003 and the effect of neurosurgical care an observational study. *Lancet.* 2005 Oct 29 – Nov 4;366 **(9496):** 1538-44
19. Lecky F on behalf of the Trauma Audit and Reserch Network Head Injury Care,. *Lecture to TraumaCare 2007 Telford.*
20. Harris CH, Smith RS, Helmer SD, Gorecki JP, Rody RB.Placement of intracranial pressure monitors by non-neurosurgeons. *Am Surg. 2002 Sept*; **68(9):** 787 -90
21. www.icnarc.org
22. Cummings J, Krsek C, Vermoch K, Matuszewski K. Intensive care unit telemedicine: review and consensus recommendations. *Am J Med Qual. 2007* Jul-Aug; **22(4)**: 239-50.