

19. Strand K, Flatten H. Severity scoring in the ICU: a review. *Acta anaesthesiologica scandinavia* 2008; **52**: 467-478.

20. Vincent J, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. *Intensive Care Med* 1996; **22**: 707-710

21. Arts D, Keizer N, Vroom M, Jonge E. Reliability and Accuracy of Sequential Organ Failure Assessment (SOFA) Scoring. *Crit Care Med*. 2005; **33(9)**: 1988-1993

22. Peres Bota D, Melot C, Lopes Ferreira F, Nguyen Ba V, Vincent JL. The Multiple Organ Dysfunction Score (MODS) versus the Sequential Organ Failure Assessment (SOFA) score in outcome prediction. *Intensive Care Med* 2002; **28**: 1619-1624

23. Antonelli M, Moreneor, Vincent J et al. Application of SOFA score to trauma patients. *Intensive Care Med* 1999; **25**: 4, 389-394

24. Teres D, Lemeshow S, Avrunin JS, Pastides H. Validation of the mortality prediction model for ICU patients. *Crit Care Med* 1987; **15**: 208-13.

25. Lemeshow S, Teres D, Klar J, Avrunin JS, Gehlbach SH, Rapoport J. Mortality prediction models (MPM II) based on an international cohort of intensive care patients. *JAMA* 1993; **270**: 2478-86.

FOCUS ON SEPSIS AND INTENSIVE CARE

A McD Johnston

Department of Military Medicine, Institute of Research & Development, West Wing, Birmingham Research Park, Vincent Drive, Edgbaston.

Abstract

The Surviving Sepsis Campaign (SSC) Guidelines collate the evidence for managing sepsis. Most of the interventions suggested by the SSC guidelines are very relevant to military critical care, including rapid microbiologic investigation, early antibiotic administration and many aspects of early goal directed therapy. Other interventions may be more difficult to provide in remote theatres of operation where resources may be limited. This article discusses the application of the SSC guidelines to deployed military hospitals, with suggestions as to which interventions are feasible, and which may not be indicated.

Introduction

In this article I discuss the military relevance of the Surviving Sepsis Campaign (SSC) Guidelines for management of sepsis. These are considered to be the current gold-standard guidelines for managing sepsis. I will attempt to highlight those parts of the guidelines particularly relevant to practice in a deployed military setting. I will also discuss other aspects of management of particular interest to the military setting.

Definition

Sepsis is defined using a consensus definition published in 1992 by the American College of Chest Physicians and the Society of Critical Care Medicine [1].

The definition requires the presence of at least two of a possible four features of the systemic inflammatory response syndrome (SIRS) in the presence of infection (Table 1).

Sepsis - two or more of the features of Systemic Inflammatory Response Syndrome in the presence of infection	
Temperature dysregulation	T > 38°C or < 36°C
Immune dysregulation	WBC < 4 or > 12x10 ⁹ (or > 10% band forms)
Tachycardia	HR > 90
Tachypnoea	RR > 20 or mechanical ventilation
Severe sepsis	Septic shock
Sepsis and organ dysfunction or hypoperfusion	Sepsis with hypotension that doesn't respond to adequate fluid resuscitation or requires vasopressors

Table 1.

Corresponding Author: Major A McD Johnston MRCP DMCC RAMC, Department of Military Medicine, Institute of Research & Development, West Wing, Birmingham Research Park, Vincent Drive, Edgbaston B15 2SQ
Email: amcdj@doctors.org.uk

Many military critical care patients with significant trauma will have features of SIRS. This may make the detection of subsequent infection more difficult than in patients presenting with internal medical conditions such as pneumonia. Sepsis should be foremost in the military specialist's mind when faced with a patient who unexpectedly deteriorates at a point in their hospital stay when they should be improving.

Sepsis in deployed military populations

Retrospective studies of "preventable" deaths from both the Vietnam conflict and US Special forces deaths in the recent past [2,3] suggest a significant minority of around 4-6% of patients die from sepsis. The incidence of sepsis in other historical conflicts is not well defined [4], however there is some data from the more recent conflicts in Iraq and Afghanistan. In patients treated at a US military hospital in Iraq around 5% of patients sustained colorectal trauma, with a 16% incidence of sepsis [5]. Data from the USS Comfort cohort of patients suggests severe infection is more likely in patients with abdominal injury, soft tissue trauma or a high Injury Severity Score[6]. At the time of writing no sepsis deaths have occurred in UK personnel injured in recent conflicts [7].

The Surviving Sepsis Campaign - adapting the guidelines to a deployed military setting

The Surviving Sepsis Campaign guidelines are international evidence based guidelines for managing sepsis [8]. They were revised in 2008, and are the basis for managing septic patients in many civilian hospitals around the world. The campaign management recommendations include a six-hour care bundle and a twenty-four hour care bundle.

A care bundle is a collection of interventions that are individually effective, and therefore should be effective when combined. Bundling these together may simplify compliance. Audit of bundle compliance is done on an all or nothing basis, where the whole bundle must be completed to count as bundle completion.

Most of the SSC guidelines are directly transferable to a military setting. However some parts of the guidelines may not be applicable, or may not be possible to apply due to equipment constraints. Unpublished data presented at the 2009 Society of Critical Care Medicine Conference suggest that adherence to the SSC guidelines results in a 7% absolute reduction in mortality from 37% to 30% in hospitals which adopt the guidelines. This reduction in mortality occurred despite incomplete compliance with the bundles described below. A recently published prospective study shows that noncompliance with the 6 hour bundle doubles the risk of death, and raises the possibility that there is a similar increase in mortality if the 24 hour bundle is not completed [9].

Management of Sepsis begins in the Emergency Department - the six hour bundle

The six-hour management bundle comprises the following elements which should be applied to patients with severe sepsis, septic shock and/or a blood lactate level greater than 4 mmol/l: [http://ssc.sccm.org/6hr_bundles]

1. Measure Serum Lactate
2. Obtain blood-cultures prior to antibiotic administration
3. Administer antibiotics within 3 hours of Emergency Department admission and within 1-hour of non-Emergency Department admission
4. If the patient is hypotensive or has a Lactate > 4 mmol/l administer a 20ml/kg fluid bolus. Administer vasopressors for hypotension that doesn't respond to fluid resuscitation to maintain a mean arterial pressure of > 65 mmHg.
5. Achieve a Central Venous Pressure of > 8 mmHg.
6. Achieve a central venous oxygen saturation (from a central line) of $\geq 70\%$.

In the Emergency Department or the Intensive Care Unit of the deployed military hospital all of these interventions should be carried out in patients with severe sepsis.

Lactate should be measured promptly, and blood or other body fluid cultures sent. Delay in administering antibiotics should be avoided where possible, as once the patient becomes hypotensive this delay markedly increases mortality [10].

Central venous pressure should be measured and fluid should be administered to attain the target of > 8 mmHg. If the patient is ventilated the target is 12-15 mmHg. Central venous oxygen saturation can be measured by taking a venous gas sample from the central line (in the original study a modified central line capable of measuring SaO₂ directly was used [11]). Central venous oxygen saturation reflects oxygen delivery as well as oxygen extraction from the peripheries. The target level is $\geq 70\%$.

Haemoglobin should be kept at a level of 7-8 g/dl. Higher levels of around 10 g/dl may be preferred in patients with neurological or cardiac disease. Counterintuitively restoring haemoglobin to normal levels is harmful in those groups of patients in whom it has been studied, with an increase in morbidity and mortality with each unit of blood administered [12,13].

Further Management - the 24-hour bundle

Implementation of the 24-hour bundle is recommended for patients with severe sepsis, septic shock and/or lactate > 4 mmol/l.

The 24-hour bundle comprises the following elements: [http://ssc.sccm.org/24hr_bundles]

1. Administer low-dose steroids by a standard policy
2. Administer recombinant human activated protein-C (rhAPC) in accordance with a standardised ICU policy
3. Maintain adequate glycaemic control (Glucose 3.9-8.3 mmol/l)
4. Maintain a median inspiratory plateau pressure of <30cm H₂O

The relevance of the 24-hour bundle to sepsis both in the civilian ITU and military ITU setting is more problematic. Firstly the benefit of some of the interventions suggested is less clear than when the original 2003 SSC guidelines were published, as the trial evidence has been in flux for some years. Landmark trials which suggested major improvements in mortality from the use of tight glucose control and physiologic doses of steroids have been repeated and the benefit has not been replicated.

In a randomised, double-blind study Annane [14] enrolled 300 patients with septic shock, and treated half of the patients with corticosteroids in the form of hydrocortisone 50 mg six hourly, along with 50 micrograms of fludrocortisone once daily. The other half received placebo. Corticosteroid administration was shown to reduce mortality by 10%. However, subsequent studies, including CORTICUS [15] suggested corticosteroids reduce the length of time the patient is dependent on vasopressors, but that this does not translate to a reduction in mortality. Pending further trial evidence some intensivists reserve corticosteroids for septic patients with hypotension unresponsive to both fluid resuscitation and vasopressors [16]. Others carry out a short synacthen test to demonstrate adrenocortical insufficiency before giving steroids, a strategy that is not possible in the deployed setting. The former course of action may be preferred when a septic patient is in shock refractory to adequate fluid resuscitation.

The benefit of tight glycaemic control has not been entirely clear-cut, with contradictory trial data. There are significant risks of hypoglycaemic complications in patients being treated with intravenous insulin to control the hyperglycaemia associated with sepsis. The large, multi-centre NICE-SUGAR study was designed to give a definitive answer to whether intensive insulin control was better than conventional glycaemic control. It has demonstrated that intensive insulin therapy to keep glucose between 3.5 and 8.3 mmol/l is harmful, increasing mortality by just under three percent. Therefore glycaemic control should aim to keep glucose < 10 mmol/l. The SSC guidelines will presumably be revised to take this into account at some point in the future [17].

Applying the 24 hour bundle is also complicated by the logistics of delivering intensive care in the austere setting. The SSC guidelines recommend administering rhAPC to patients who fulfill particular criteria in accordance with local guidelines. rhAPC is extremely expensive, would be used very infrequently in a typical field hospital, and may cause life-threatening haemorrhage in patients who have had recent surgery or major trauma, i.e. in the group probably most likely to develop sepsis in a military setting. rhAPC is not kept in stock in deployed UK field hospitals.

Limiting plateau pressure in mechanically ventilated patients is extremely important, and perhaps more so in patients with or at risk of sepsis. Plateau pressure should be kept below 30 cm H₂O. Where possible lung-protective ventilation, with tidal volumes of 6 ml/kg ideal body weight should be used in all patients with sepsis to reduce the risk of multi-organ failure.

Other relevant issues:

Source Control

Source control is the term for removal of a source of infection, such as an intracavitary abscess, anastomotic leak, infected tissue or device (e.g. central venous catheter). Wounds caused by ballistic trauma are particularly prone to infection, and standard military teaching is to debride such wounds back to healthy tissue. UK nationals with traumatic injuries will usually have been repatriated before source control issues become apparent, however patients with non-surgical conditions, host nation nationals, and enemy combatants cared for in the field hospital may manifest signs of sepsis due to an obvious or concealed source of infection. Attention should be paid to the original injury, the possibility of

missed injury, the possible complications of surgical procedures that have been undertaken, and appropriate remedial action should be taken. This might include CT imaging to look for collections of pus secondary to empyema, or following gastrointestinal surgery. Review should include consideration of removal of devices such as the central venous catheter placed several days previously. Where a likely source of infection is found, action should be taken to remove it as soon as possible. The least invasive method of source control is usually indicated, particularly if the patient is shocked. Resuscitation of the shocked patient to improve physiologic parameters may be necessary prior to carrying out a source control intervention. It should be remembered that delay in removing the source carries a high mortality, approaching 100% in patients in whom source control is not carried out [18].

There are numerous infections that should be considered when dealing with military patients with sepsis.

Soft tissue infections such as necrotising fasciitis may present spontaneously, or following injury to the skin. Necrotising fasciitis manifests as a rapidly spreading severely painful soft tissue infection, and requires immediate surgical debridement and appropriate antibiotic therapy to limit its spread.

Other serious skin infections may be caused by strains of *Staphylococcus aureus* that produce Panton-Valentin Leucocidin (PVL). This toxin kills leucocytes and causes fulminant sepsis, with rapid deterioration. Immediate antibiotic therapy is required. Other staphylococcal syndromes to be considered include Staphylococcal Toxic Shock Syndrome, which may occur in female patients with a retained tampon, or in male or female patients with staphylococcal infection that produces Toxic Shock Syndrome Toxin (TSST) [19]. Patients with significant soft tissue injury following blast or ballistic trauma may be infected with the fungus *Saksenaia vasiformis*. This organism tracks up the vasculature of apparently healthy tissue, leading to vascular compromise. Immunocompetent patients do not appear to develop sepsis along with local effects of the infection.

Epidemic Meningococcal or Pneumococcal disease, once a significant cause of sepsis deaths in military populations appear to be rare now that all UK soldiers are vaccinated on entry to the military.

Other sources of sepsis include soft tissue, orthopaedic and burn injuries with secondary infection. In military patients with burns superadded infection can be devastating. Multidrug Resistant (MDR) organisms are commonly found when bacteraemia occurs. In this group of patients the presence of bacteraemia increases morbidity and mortality, particularly when *Klebsiella Pneumonia* or other MDR organisms are present in blood cultures.

Indwelling medical devices such as Central Venous Catheters (CVC) are associated with significant rates of infection and sepsis. Some of this is preventable in the civilian setting by instituting relatively simple measures such as ensuring that sterile precautions and appropriate antiseptics are used at the time of insertion. These measures can genuinely reduce line infection rates to zero in civilian hospitals [20], although whether they are as effective in austere settings is unknown.

Acinetobacter

Military patients seem to be particularly prone to *Acinetobacter Baumannii* infections [21], possibly acquired in the military evacuation chain rather than from exposure on the ground [22]. Injured UK personnel may be infected with the same strains of *Acinetobacter* as US casualties [23]. *Acinetobacter* causes increased mortality [24] including in patients with burns [25]. This organism is sometimes resistant to numerous antibiotics, and Multidrug resistant (MDR) *Acinetobacter* may complicate management significantly [26]. MDR *Acinetobacter* may also pose a threat to civilian patients in the receiving hospital [27].

Fluids

Which fluid to use for resuscitation in septic patients remains a matter for debate. Despite decades of research there is not strong evidence favouring either colloid or crystalloid solutions as the preferred resuscitation fluid. The large multi-centre SAFE Study has shown that albumin, the "ideal" colloid, is not inferior to saline in terms of safety [28]. Concerns that much larger volumes of crystalloids may be required as compared with colloids have been partially alleviated by the SAFE study which showed that about 1.4 times more saline was required than albumin for an equivalent blood pressure response. Some authors advocate not using synthetic colloids in sepsis [29], as there is some evidence these may worsen outcome by increasing the risk of renal failure or death. Hartmann's solution or 0.9% saline, although imperfect, remain the fluids of choice in septic patients.

Antibiotics - rational prescribing

The SSC guidelines recommend using a broad spectrum antibiotic that is likely to be effective against pathogens from the presumed source.

The British National Formulary gives guidance on which antibiotics are appropriate for sepsis arising from various sites. Antibiotic choice should also be informed by local patterns of antibiotic resistance and expert advice from a microbiologist. Once an organism is formally identified by the laboratory a narrow spectrum antibiotic should be used instead, if appropriate. Where no laboratory identification is available clinical judgment is required.

Note that laboratory monitoring of gentamicin and vancomycin levels, readily available in the UK, is not available in the deployed field hospital. Where vancomycin or gentamicin is given it should be for only a short period of time pending evacuation.

Paediatric patients

A significant proportion of the patients admitted to deployed UK military hospitals are children, usually with trauma. They are at risk of sepsis during the period following any surgical intervention. Paediatric patients differ from adults in many ways, and familiarity with the care of paediatric patients is important for military health professionals. When sepsis occurs in children early treatment may result in an even more dramatic response than in adults. Again early antibiotic and fluid administration are crucial.

The initial volume of fluid to be administered to septic children is 20 mg/kg body weight, as in adults. 0.9% Saline or 4.5% Albumin are recommended. More than 60 ml/kg of fluid may be required in the first hour [30], and potentially more than 200 mg/kg in the first 24 hours. After the first or second 20 ml/kg bolus the preferred fluid is 4.5% Albumin [31]. Mechanical ventilation, inotropes and central venous pressure monitoring may be required if repeated fluid boluses alone do not improve the child's condition. Formulae for calculating body weight from age are anecdotally less useful in countries affected by conflict as children in conflict areas are often malnourished.

Aspects of the SSC guidelines that we cannot apply in the deployed military population

There are some aspects of the SSC guidelines that we are not able to apply. For example renal replacement therapy is not provided for, and patients requiring this treatment modality will require evacuation. Intravenous immunoglobulin is not in the SSC Guidelines, but is used in some centres for the treatment of sepsis, and has evidence of efficacy. IVIG is not available in the field hospital. Interventional radiology source control techniques are not available at present, although the more simple techniques

such as ultrasound guided placement of an intercostal drain to drain an empyema may be performed by physicians with prior experience of this technique.

Special circumstances relevant to the military - applying the bundles for purposes they weren't designed for.

There are some caveats to adapting the SSC guidelines for military use. The guidelines are not validated for use with biological warfare casualties, but many of the principles of managing sepsis are relevant to this, and the SSC guidelines make a good template. In the UK patients who live in remote rural settings may not have access to immediate medical care, however military patients in remote settings always do, either in the form of, soldiers with advanced first aid training, paramedics, or their Regimental Medical Officer. When evacuation to hospital is not immediately possible due to operational constraints, treatment of the septic patient using the SSC guidelines can still be started. Fluid boluses and antibiotics will be available even in these remote conditions pending transfer to a higher level of care. So some of the "hospital" interventions may be performed prehospital by military medical providers.

Evacuation

Patients suffering from sepsis may be extremely unstable in the initial stages of the illness, and indeed, a significant proportion die very rapidly despite aggressive medical management. The Royal Air Force's Critical Care Air Support Team (CCAST) has expertise in repatriating extremely ill patients back to the Royal Centre for Defence Medicine at University Hospital Birmingham. CCAST also have the capability to provide continuous renal replacement therapy during evacuation. Most UK nationals with sepsis will be evacuated to the UK as soon as their clinical condition permits. Host nation patients are treated in country, and sent to local hospitals when their condition permits.

Summary

Compliance with the SSC guidelines is the ideal standard of care in civilian hospitals. In an established military hospital such as that in Afghanistan the majority of the interventions recommended in the SSC guidelines can be carried out. The military health care system has the major advantage of a very highly motivated, cohesive medical team composed of experienced nurses and physicians. This system facilitates early recognition and appropriate treatment of life threatening conditions such as sepsis where timely intervention clearly saves lives.

References

- Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, *et al.* Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM consensus conference committee. American College of Chest Physicians/Society of Critical Care Medicine. *Chest* 1992; **101**: 1644-55.
- Blood CG, Puyana JC, Pityk PJ, Hoyt DB, Bjerke HS, Fridman J, *et al.* An assessment of the potential for reducing future combat deaths through medical technologies and training. *The Journal of Trauma* 2002; **53**: 1160-5.
- Holcomb JB, McMullin NR, Pearse L, Caruso J, Wade CE, Oetjen-Gerdes L, *et al.* Causes of death in U.S. Special operations forces in the global war on terrorism: 2001-2004. *Ann Surg* 2007; **245**: 986-91.
- Murray CK. Infectious disease complications of combat-related injuries. *Crit Care Med* 2008; **36**: S358-64.
- Murray CK. Epidemiology of infections associated with combat-related injuries in Iraq and Afghanistan. *The Journal of Trauma* 2008; **64**: S232-8.
- Petersen K, Riddle MS, Danko JR, Blazes DL, Hayden R, Tasker SA, Dunne JR. Trauma-Related infections in battlefield casualties from Iraq. *Ann Surg* 2007; **245**: 803-11.
- Hodgetts T, Davies S, Midwinter M, Russell R, *et al.* Operational mortality of UK service personnel in Iraq and Afghanistan: a one year analysis 2006-7. *J Royal Army Medical Corps* 2008; **153**: 252-4.
- Dellinger R, Levy M, Carlet J, Bion J, Parker M, Jaeschke R, *et al.* Surviving sepsis campaign: International guidelines for management of severe sepsis and septic shock: 2008. *Crit Care Med* 2008; **36**: 296-327.
- Gao F, Melody T, Daniels DF, Giles S, Fox S. The impact of compliance with 6-hour and 24-hour sepsis bundles on hospital mortality in patients with severe sepsis: A prospective observational study. *Critical Care* 2005; **9**: R764-70.
- Kumar A, Roberts D, Wood KE, Light B, Parrillo JE, Sharma S, *et al.* Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. *Crit Care Med* 2006; **34**: 1589-96.
- Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, *et al.* Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001; **345**: 1368-77.
- Hébert PC, Wells G, Blajchman MA, Marshall J, Martin C, Pagliarello G, *et al.* A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. Transfusion requirements in critical care investigators, canadian critical care trials group. *N Engl J Med* 1999; **340**: 409-17.
- Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, *et al.* The CRIT study: Anemia and blood transfusion in the critically ill-current clinical practice in the united states. *Crit Care Med* 2004; **32**: 39-52.
- Anname D, Sébille V, Charpentier C, Bollaert P, François B, Korach J, *et al.* Effect of treatment with low doses of hydrocortisone and fludrocortisone on mortality in patients with septic shock. *JAMA* 2002; **288**: 862-71.
- Sprung CL, Anname D, Keh D, Moreno R, Singer M, Freivogel K, *et al.* Hydrocortisone therapy for patients with septic shock. *N Engl J Med* 2008; **358**: 111-24.
- Bauer W, Ball J, Grounds M. Unanswered questions from Corticus and pragmatic suggestions. *Critical Care* 2008; **12**: 426.
- NICE-SUGAR Investigators. Intensive versus conventional glucose control in critically ill patients. *N Engl J Med* 2009; **360**: 1283-97.
- Kumar A, Kazmi M, Ronald J, Seleman M, Roberts D, Gurka D, *et al.* Rapidity of source control implementation following onset of hypotension is a major determinant of survival in human septic shock. *Crit Care Med* 2004; **32**: A158.
- Berkley SF, McNeil JG, Hightower AW, Graves LM, Smith PB, Broome CV. A cluster of blister-associated toxic shock syndrome in male military trainees and a study of staphylococcal carriage patterns. *Military Medicine* 1989; **154**: 496-9.
- Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, *et al.* An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006; **355**: 2725-32.
- Control CFD, (CDC) P. Acinetobacter baumannii infections among patients at military medical facilities treating injured U.S. Service members, 2002-2004. *MMWR Morb Mortal Wkly Rep* 2004; **53**: 1063-6.
- Griffith ME, Lazarus DR, Mann PB, Boger JA, Hoshenthal DR, Murray CK. Acinetobacter skin carriage among US army soldiers deployed in Iraq. *Infection Control and Hospital Epidemiology* 2007; **28**: 720-2.
- Turton JF, Kaufmann ME, Gill MJ, Pike R, Scott PT, Fishbain J, *et al.* Comparison of acinetobacter baumannii isolates from the United Kingdom and the United States that were associated with repatriated casualties of the Iraq conflict. *J Clin Microbiol* 2006; **44**: 2630-4.
- Falagas ME, Rafailidis PI. Attributable mortality of Acinetobacter baumannii: No longer a controversial issue. *Critical Care* 2007; **11**: 134.
- Albrecht MC, Albrecht MA, Griffith ME, Murray CK, Chung KK, Horvath EE, *et al.* Impact of acinetobacter infection on the mortality of burn patients. *J Am Coll Surg* 2006; **203**: 546-50.
- Arias CA, Murray BE. Antibiotic-Resistant bugs in the 21st century-a clinical super-challenge. *N Engl J Med* 2009; **360**: 439-43.
- Jones A, Morgan D, Walsh A, Turton J, Livermore D, Pitt T, *et al.* Importation of multidrug-resistant acinetobacter spp infections with casualties from Iraq. *The Lancet Infectious Diseases* 2006; **6**: 317-8.
- Finfer S, Bellomo R, Boyce N, French J, Myburgh J, Norton R. A comparison of albumin and saline for fluid resuscitation in the intensive care unit. *N Engl J Med* 2004; **350**: 2247-56.
- Downar J, Lapinsky SE. Pro/con debate: Should synthetic colloids be used in patients with septic shock? *Critical Care* 2009; **13**: 203.
- Bernsten AD, Soni N. Oh's Intensive Care Medicine. 2009.
- Mackway-Jones K. Advanced Paediatric Life Support: The practical approach. Blackwell 2005.