Implementation and outcomes of a severe sepsis protocol in an Australian tertiary hospital

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ABSTRACT

Objective: To evaluate the effect of implementation of a sepsis protocol.

Design: Before and after cohort study.

Setting: Level III ICU in a tertiary regional hospital, February – July, 2006 (before intervention) and 2007 (after).

Participants: Adult patients who fulfilled criteria for severe sepsis or septic shock within 48 hours of ICU admission.

Intervention: Implementation of a locally modified sepsis protocol.

Main outcome measures: Delivery of process of care components, and ICU and hospital mortality.

Results: A total of 110 patients were included in the study: 44 in the pre-protocol group, and 66 in the post-protocol group. Demographic variables and severity of illness variables were similar in the two groups except for a lower incidence of respiratory sepsis in the post-protocol group. Post-protocol, there was a shorter time to initiation of appropriate antibiotics, and an increase in the use of vasopressors, deep vein thrombosis prophylaxis, and nutritional support, with no difference in ICU or hospital mortality. There was no difference in resuscitation end-points at 6, 24, and 72 hours.

Conclusions: Implementation of a sepsis protocol led to a change in the delivery of care with no reduction in mortality in patients with severe sepsis and septic shock admitted to a Level III ICU in a tertiary hospital.

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Sepsis is a clinical syndrome that complicates severe infection and is characterised by systemic inflammation and widespread tissue injury. It is common and remains a leading cause of mortality in critically ill patients. A retrospective analysis of patients admitted to Australian and New Zealand intensive care units over a 9-year period reported an increasing incidence and an overall hospital mortality of 27.6% for patients with severe sepsis and septic shock.[1]

Recognition of the high mortality associated with severe sepsis has led to an international effort to improve outcomes — the Surviving Sepsis Campaign (SSC).[2] The campaign set a goal of reducing mortality due to sepsis by 25% in 5 years, through the creation, publishing, implementation and evaluation of a set of evidence-based guidelines for the management of severe sepsis and septic shock. This process culminated in the development and publication of the *Surviving Sepsis Campaign guidelines* in 2004,[2] with a revised version published in 2008.[3] Although individual components of the Guidelines have been debated,[4,5] there have been reports of improved delivery of care and reduced mortality following the implementation of locally modified "sepsis bundles" in individual ICUs in Europe, the United Kingdom and North America.[6-10]

The impact of introducing a protocol, or bundle, for the management of sepsis may depend on the baseline clinical management in a hospital system. Australian and New Zealand ICUs have reported decreasing hospital mortality from sepsis, from 35.6% in 1997 to 21.2% in 2005,[1,11] an incidence similar to that in the treatment or post-bundle arm in reported studies.[6,10,12] The reasons for this are not clear, but it implies that the mortality benefits observed after implementation of sepsis bundles in previous studies may not apply to the Australian and New Zealand ICU population.

To date, no studies have examined the effect of implementation of a sepsis bundle in an Australian setting, or reported a detailed observation of practice. The goal of this study was to evaluate the effect of implementation of a sepsis protocol on treatment and outcomes in patients with severe sepsis or septic shock in an Australian tertiary hospital.

Methods

The study was conducted in a 19-bed, Level III ICU in a 450-bed tertiary regional hospital. The study was approved by the local human research and ethics committee, and the need for informed consent was waived.

Between March 2005 and August 2006, emergency medicine, intensive care and infectious disease physicians developed the Barwon–South West Adult Sepsis Protocol (final version, Appendix 1). The protocol was adapted from the *Surviving Sepsis Campaign guidelines*[2] in line with a local consensus interpretation of the literature. A program

Table 1. Patient demographic and baseline characteristics

Characteristic	Pre-protocol ($n = 44$)	Post-protocol ($n = 66$)	*P*
Age (years)*	62.0 (48.5–75.0)	63.5 (49.5–75.0)	0.98
No. female (%)	20 (45%)	30 (45%)	1.00
Mean weight (kg) (SD)	72.1 (16.1)	78.8 (19.3)	0.05
APACHE II score*	23 (11–32)	18.5 (15–25)	0.49
APACHE III score*	77 (49–108)	71.5 (55–84.5)	0.61
Medical/surgical	40/4	55/11	–
Comorbidity†			
Diabetes mellitus	11 (25%)	15 (23%)	0.78
Chronic renal disease	6 (14%)	7 (11%)	0.63
Chronic lung disease	7 (16%)	8 (12%)	0.57
Chronic liver disease	1 (2%)	7 (11%)	0.2
Chronic heart failure	4 (9%)	4 (6%)	0.81
Immunosuppression	11 (25%)	11 (17%)	0.28
Cancer	10 (23%)	17 (26%)	0.72
Nil	15 (34%)	20 (30%)	0.68
Infection source†			
Abdominal	7 (16%)	15 (23%)	0.38
Bone	1 (2%)	1 (2%)	1.00
Central nervous system	0	2 (3%)	0.72
Endocarditis	0	1 (2%)	1.00
Ear, nose, throat	0	1 (2%)	1.00
Lung	27 (61%)	27 (41%)	0.04
Soft tissue	1 (2%)	4 (6%)	0.66
Thoracic	0	2 (3%)	0.72
Urinary tract	5 (11%)	8 (12%)	0.90
Other	0	2 (3%)	0.72
Unknown	0	3 (5%)	0.42

* Median (interquartile range). † Frequency (%).

Table 2. Entry criteria for severe sepsis (frequency [%])

Criterion	Pre-protocol ($n = 44$)	Post-protocol ($n = 66$)	*P*
SBP < 90 mmHg	23 (52%)	26 (39%)	0.18
SBP decrease > 40 mmHg	15 (34%)	18 (27%)	0.45
MAP < 65 mmHg	24 (55%)	26 (39%)	0.12
Lactate > 4 mmol/L	15 (34%)	18 (27%)	0.45
Anion gap > –20	8 (19%)	8 (12%)	0.38
Bicarbonate < 16 mmol/L	12 (27%)	13 (20%)	0.35

MAP = mean arterial pressure. SBP = systolic blood pressure.

of nursing and medical education and implementation was undertaken in the emergency department and ICU over a 4-month period from September 2006 to January 2007. This consisted of a series of lectures and informal presentations, displaying the protocol in high-flow areas of the emergency department and ICU, and providing supporting materials (pamphlets, folders) in both departments and on the hospital intranet.

Patients admitted to the ICU with severe sepsis or septic shock, as defined by the American College of Chest Physicians/Society of Critical Care Medicine consensus conference definitions (Appendix 2),[12] were identified over pre-protocol and post-protocol periods of 6 months each.

The pre-protocol group was identified retrospectively, and included all patients over 18 years of age who fulfilled criteria for severe sepsis or septic shock within 48 hours of an ICU admission between 1 February and 31 July 2006. Severe sepsis and septic shock were identified by screening patient records for the ICD-10 AM codes for sepsis (Appendix 3). Following this, the diagnosis of severe sepsis and septic shock on admission to the ICU was determined by review of the patient records and an ICU electronic patient database to establish whether criteria for severe sepsis and septic shock were met.

The post-protocol group was identified prospectively and included all patients over 18 years of age who fulfilled criteria for severe sepsis or septic shock within 48 hours of an ICU admission between 1 February and 31 July 2007. Patients admitted with severe sepsis or septic shock were identified through daily screening by research coordinators of all ICU admissions.

Patients were excluded if they fulfilled any of the following criteria: age less than 18 years, pregnancy, pre-hospital cardiac arrest, a do-not-resuscitate order, or not expected to survive 24 hours.

Infection was defined as the presence of a pathogenic micro-organism in a usually sterile milieu (such as blood, abscess fluid, cerebrospinal fluid, or ascitic fluid) and/or clinically suspected infection, plus the administration of antibiotics. Appropriate antibiotics were defined as antibiotics prescribed in accordance with empirical guidelines, or targeted to microorganism sensitivity when available. Admission sepsis was defined as sepsis, severe sepsis, or septic shock within 48 hours of admission to the ICU (Appendix 2).

Clinical information collected included age, sex, admission category, APACHE II and III scores, site of infection, fluid resuscitation, red cell transfusion, requirement for and duration of ventilation, requirement for continuous renal replacement therapy, time of antibiotic administration, plus the use of inotropes, vasopressors, low-dose corticosteroids, recombinant activated protein-C (rAPC), deep vein thrombosis prophylaxis (DVT), nutritional support, stress-ulcer prophylaxis or insulin infusion. ICU and hospital length

of stay (LOS) and mortality were also recorded. Treatments and physiological data were collected at 0, 6, 24, and 72 hours, with Time 0 defined as the time at which the patient first met the criteria for sepsis. Data were entered into a spreadsheet (Microsoft Excel, 2004).

The pre-protocol and post-protocol groups were compared using a two-sample *t* test, Mann–Whitney test, χ^2 statistic or Fisher's exact test, as appropriate. A $P \leq 0.05$ was considered significant.

Results

A total of 110 patients fulfilled the inclusion criteria during the study period, 44 in the pre-protocol period, and 66 in the post-protocol period. Baseline age, sex distribution, comorbidities, and APACHE scores were similar, although mean body weight was significantly greater in the post-protocol group (Table 1). The infection source differed between the groups, with a lower incidence of respiratory sepsis in the post-protocol group. The criteria for severe sepsis and septic shock fulfilled at entry were similar in the two groups (Table 2). Analysis by source of referral showed a non-significant increase in patients referred from the wards versus the emergency department in the post-protocol group. Most patients (62/110, 56%) met the inclusion criteria after admission to the ICU (Table 3).

Processes of care differed between the pre- and post-protocol groups. In the post-protocol group, a reduction in time to administration of appropriate antibiotics was observed during the initial stage (0–6 hours), and an increase in vasopressor use, DVT prophylaxis, and nutritional support was observed over the first 72 hours (Table 4). For all other interventions, including fluid resuscitation, red cell transfusion, inotrope administration, invasive monitoring, mechanical ventilation, and low-dose corticosteroid, stress-ulcer prophylaxis, and insulin administration, no difference was observed.

There was no difference in physiological end-points at 6, 24, and 72 hours between the groups (Table 5), and no significant effect of the protocol on ICU or hospital mortality. An increase in hospital LOS was observed in the post-protocol group (Table 6).

Discussion

To our knowledge, this is the first study describing the effect of the implementation of a sepsis bundle on the process of care and outcome in patients with severe sepsis and septic shock in an Australian ICU. We provide detailed information about the management of patients with severe sepsis and septic shock, and our results confirm the previously reported low baseline hospital mortality following

Table 3. Patient origin and location at onset of severe sepsis (frequency [%])

Origin, location at sepsis onset	Pre-protocol (*n* = 44)	Post-protocol (*n* = 66)	*P*
Patient origin, ED			
Total	29 (66%)	32 (48%)	0.07
ED	18	21	0.77
ICU	11	11	
Patient origin, ward			
Total	15 (34%)	34 (52%)	0.07
Ward	3	6	1.00
ICU	12	28	

ED = emergency department.

Table 4. Process of care (frequency [%] or median [IQR])

Process of care	Pre-protocol (*n* = 44)	Post-protocol (*n* = 66)	*P*
Care delivery, first 6 h			
Initial antibiotics appropriate	36 (82%)	62 (94%)	0.09
Time to appropriate antibiotics (min)	0 (0–75)	0 (0–1)	0.01
Blood cultures in first 2 h	34 (77%)	47 (71%)	0.48
> 20 mL/kg fluid	37 (84%)	48 (73%)	0.16
Central venous line	33 (75%)	55 (83%)	0.08
Total intravenous fluid (mL)	2823 (2000–4300)	2946 (1428–4500)	0.68
Vasopressor administration	32 (73%)	52 (79%)	0.46
Inotrope administration	3 (7%)	2 (3%)	0.63
Red cells transfused	3 (7%)	8 (12%)	0.57
Mechanical ventilation	20 (45%)	39 (59%)	0.16
Care delivery, total 72 h			
Total intravenous fluid (mL)	6990 (4440–10350)	7730 (4920–9800)	0.73
Red cells transfused	10 (23%)	13 (20%)	0.70
Vasopressor administration	34 (77%)	64 (97%)	0.00
Inotrope administration	6 (14%)	3 (5%)	0.18
Mechanical ventilation	25 (57%)	43 (65%)	0.38
Low-dose corticosteroids	16 (36%)	21 (32%)	0.62
DVT prophylaxis	32 (73%)	61 (92%)	0.01
Stress ulcer prophylaxis*	20 (80%)	40 (93%)	0.23
Insulin therapy*	22 (88%)	41 (95%)	0.51
Activated protein C	0	1 (2%)	1.00
Nutritional support*†	15 (60%)	39 (91%)	0.01

DVT = deep vein thrombosis.
* Applied to patients receiving mechanical ventilation (pre = 25, post = 43). † Received nutritional support within 48 h of ICU admission.

Table 5. Physiological parameters during first 72 hours (median [IQR], mean ± SD, or frequency [%])

Parameter	Pre-protocol ($n = 44$)	Post-protocol ($n = 66$)	P
Time, 0 h			
Heart rate (beats/min)	101 (87–112)	98 (85–120)	0.85
Systolic BP (mmHg)	105 (85–120)	100 (92–114)	0.75
MAP (mmHg)	72 (62–81)	70 (62–76)	0.53
CVP (mmHg)	12 (10–15)	11 (9–12)	0.13
pH	7.34 (7.27–7.40)	7.35 (7.26–7.40)	0.86
Base excess (mmol/L)	–4.75 (–8.2 to –0.2)	–3.85 (–7.2 to –1.1)	0.59
Haematocrit (%)	35 ±8	35 ±8	0.96
Time, 6 h			
Heart rate (beats/min)	94 (80–110)	96 (80–109)	0.76
Systolic BP (mmHg)	110 (100–120)	112 (101–122)	0.45
MAP (mmHg)	75 (68–86)	76 (68–82)	0.99
CVP (mmHg)	12 (9–14)	11 (10–14)	0.68
Urine output (mL/h)	50 (30–20)	50 (20–121)	0.82
Lactate (mmol/L)	1.7 (1.2–2.8)	1.8 (1.3–2.9)	0.76
pH	7.34 (7.2–7.4)	7.34 (7.3–7.4)	0.58
Base excess (mmol/L)	–3.5 (–8 to –1.5)	–4.8 (–7.5 to –0.2)	0.50
Haematocrit (%)	30.6 ±7	32.9 ±6	0.09
Time, 72 h			
Heart rate (beats/min)	86 (77–102)	88 (78–99)	0.59
Systolic BP (mmHg)	127 (110–141)	120 (108–136)	0.30
MAP (mmHg)	86 (72–94)	81 (74–90)	0.53
Urine output (mL/h)	30 (9–85)	60 (35–120)	0.06
Lactate (mmol/L)	1.5 (1.1–2.3)	1.5 (1.2–2.1)	0.85
pH	7.44 (7.35–7.47)	7.44 (7.37–7.47)	0.74
Base excess (mmol/L)	2.5 (–0.8 to 6.9)	1.2 (–3.6 to 3.5)	0.08
Haematocrit (%)	30.9 ±5.2	29.7 ±5.2	0.36

BP = blood pressure. CVP = central venous pressure.
MAP = mean arterial pressure.

Table 6. Outcomes (mean ± SD, frequency [%], or median [IQR])

Outcome	Pre-protocol ($n = 44$)	Post-protocol ($n = 66$)	P
Ventilation duration (h)	76 ±132	86 ±124	0.67
CRRT	8 (18%)	9 (14%)	0.52
ICU LOS (days)	3.0 (2.0–8.8)	4.0 (2.8–8.3)	0.41
ICU mortality	8 (18%)	9 (14%)	0.52
Hospital LOS (days)	11.5 (7.0–18.8)	16.5 (9.8–30.3)	0.03
Hospital mortality	10 (23%)	13 (20%)	0.70

CRRT = continuous renal replacement therapy. LOS = length of stay.

severe sepsis and septic shock in Australian and New Zealand ICUs.[1,11] We also demonstrate that the implementation of a sepsis bundle resulted in changes to the delivery of care.

Previous studies have reported significant decreases in mortality in similar-sized populations following the introduction of a sepsis bundle.[7-10] However, these studies differed in their baseline management of sepsis and in the content of their sepsis bundles. Although all reported changes in practice following implementation of the bundle, the effects on individual bundle components varied markedly.

For example, after implementation of a sepsis bundle in a prospective study of 120 patients, Micek et al reported an increase in early (60% before v 86.7% after, $P = 0.001$) and appropriate (71.7% v 86.7%, $P = 0.04$) antibiotic administration, volume of intravenous fluid administered in the ED (2825 v 3789 mL, $P = 0.002$), and proportion of patients who received red cell transfusions (6.7% v 20%, $P = 0.03$).[7] These changes were associated with a reduction in the use of vasopressors (100% before v 71.7% after, $P < 0.001$), corticosteroids (50% v 21.7%, $P = 0.001$) and activated protein C (11.7% v 3.3%, $P = 0.08$), and a decrease in 28-day mortality (48.3% v 30%, $P = 0.04$). In a retrospective trial of 60 patients, Kortgen et al also reported a decrease in mortality (53% before v 27% after, $P < 0.05$), with increased use of dobutamine (5% v 21%), insulin (18% v 30%), activated protein C (0 v 7%) and corticosteroids (13% v 30%), but no difference in fluid resuscitation at 6 hours (2450 v 2750 mL) or at 24 hours (7500 v 8000 mL), or the proportion of patients who received red blood cells (8% v 12%).[9]

Although the effects on individual components of sepsis therapies differed, these studies shared a high baseline mortality, and a reduction in mortality after implementation of a practice-changing sepsis protocol in a small study population. In contrast, in our similarly designed study, we observed a low baseline mortality, and no reduction following the introduction of a practice-changing sepsis protocol. Possible explanations for this lack of effect on mortality include:

- differences in baseline care, resulting in lower baseline mortality;
- a lack of efficacy of the "intervention" (ie, the sepsis bundle); or
- problems in study design.

Does our baseline care differ from that in other studies? The low baseline mortality in our study (23%) compared with that in other before-and-after trials (Micek et al, 48.3%;[7] Kortgen et al, 53%;[9] and Rivers et al, 46.5%[13]) suggests that our baseline care for severe sepsis is more effective. This may reflect organisational differences between ICUs in different countries. Bellomo et al[14] sug-

gested factors including training, research, nursing ratios, and closed versus open unit design as potential reasons that outcomes were better in Australian and New Zealand ICUs than in other countries. The ARISE-ANZICS APD study found that mortality from severe sepsis in Australia and New Zealand gradually declined over the 9-year study period, and was lower than that reported in international studies, but that there was insufficient information to determine the reasons for the decline.[1]

Our study provides a detailed description of clinical practice before the introduction of a sepsis protocol. We observed a consistent pattern of early administration of appropriate empirical antibiotics, moderate fluid resuscitation, early placement of invasive monitoring, high level of use of vasopressors, and low levels of use of red blood cells, mixed venous oxygen catheters, inotropes, pulmonary artery catheters and rAPC. However, although these observations provide information about the process of care, they do not necessarily imply a higher standard of care. It is difficult to compare baseline care with that in other studies while there is no consensus about the "gold standard" for each component of the bundle, or about which components should be included in a bundle, and which aspects of the bundle are referred to in publications. For example, current evidence suggests that early antibiotic administration is an important component that improves outcomes in severe sepsis.[15,16] However, only our study and that of Micek et al[7] reported the baseline incidence of initial administration of appropriate antibiotics.

Was the intervention effective? The term "intervention" refers to the sepsis protocol as a whole, rather than individual components. It is unclear whether the effectiveness of bundles depends on completion of every individual element of the bundle, or whether some elements are more important than others. The implementation of the sepsis protocol seems to have been effective in our institution, with observed changes in care, including decreased time to administration of appropriate antibiotics, and increased use of vasopressors, DVT prophylaxis and nutritional support. This reflects the focus of the sepsis protocol on early recognition of sepsis, early administration of empirical antibiotics, defence of blood pressure through early placement of invasive monitoring and commencement of vasopressors in patients who do not respond to fluid resuscitation, and administration of general ICU therapies, including DVT prophylaxis, insulin therapy, stress-ulcer prophylaxis, and nutritional support.

Although we observed changes in practice following the implementation of the sepsis protocol, a greater effect might have been achieved had we had more resources. A study of barriers to implementing protocol-based sepsis resuscitation in the emergency department reported that physicians perceived that the implementation required more time, resources and nursing staff. They suggested that early recognition and treatment may require a more intense program, with dedicated resources both in the community and hospital.[17] In our study, extensive education was provided, but we did not formally assess medical and nursing knowledge and acceptance, or identify barriers to implementation of the sepsis protocol. Furthermore, we did not provide additional resources to help identify and manage patients with severe sepsis.

Limitations in study design may also have affected outcomes in this study. Before-and-after trials are limited, as they are non-randomised, do not account for uncontrolled changes in practice or confounding variables, and cannot determine the effect of specific interventions.

There may have been differences in patient populations caused by the retrospective identification of the pre-protocol group, leading to differences in patient identification and inclusion. There was a trend toward the patients being less sick in the post-protocol group, although the differences in median APACHE II and III scores between the pre- and post-protocol groups (23 v 18.5 and 77 v 71.5, respectively) were not significant. Arguably, a reduction in severity of illness scores at admission is a goal of a sepsis protocol. Early identification and admission of patients to the ICU, minimising deterioration in the physiological variables that contribute to the APACHE II and APACHE III scores, would be expected to reduce those scores in the post-protocol group.

The post-protocol group had a lower incidence of sepsis from a respiratory source than the pre-protocol group, and a trend to more ICU admissions from the wards rather than from the emergency department. An increase in the identification of patients with sepsis in general wards might be expected following the implementation of a sepsis protocol. The increase in the number of hospital inpatients, with a longer pre-ICU LOS, in the post-protocol group may have contributed to the increased hospital LOS observed in this group.

Another potential limitation is that, given the low baseline mortality present in Australian ICUs, this study is of insufficient size to detect a mortality benefit. However, the primary aim was to assess the effect of a sepsis protocol on the process of care, and the absence of an effect on mortality is in itself an important observation. Previous reports of positive mortality benefits in studies with similar sample sizes led the authors of those reports to conclude that sepsis bundles should be used routinely.[7-10] A much larger study would be required before such a conclusion could be applied to hospitals with low baseline sepsis mortality.

Finally, our findings about the origin and timing of transfer to the ICU of patients with severe sepsis may be of

interest for future studies investigating the sepsis care process. Among patients who developed sepsis in the emergency department, the median time to ICU admission was about 2 hours after they fulfilled the criteria for sepsis in both the pre-protocol and post-protocol groups. This suggests that severe sepsis is managed — at least in our study —predominantly in an intensive care setting.

In conclusion, we report that the introduction of a standardised sepsis protocol can lead to a change in the delivery of care for patients with severe sepsis and septic shock. A larger study would be required to assess the effect on mortality, given the low baseline mortality reported in Australian and New Zealand ICUs.

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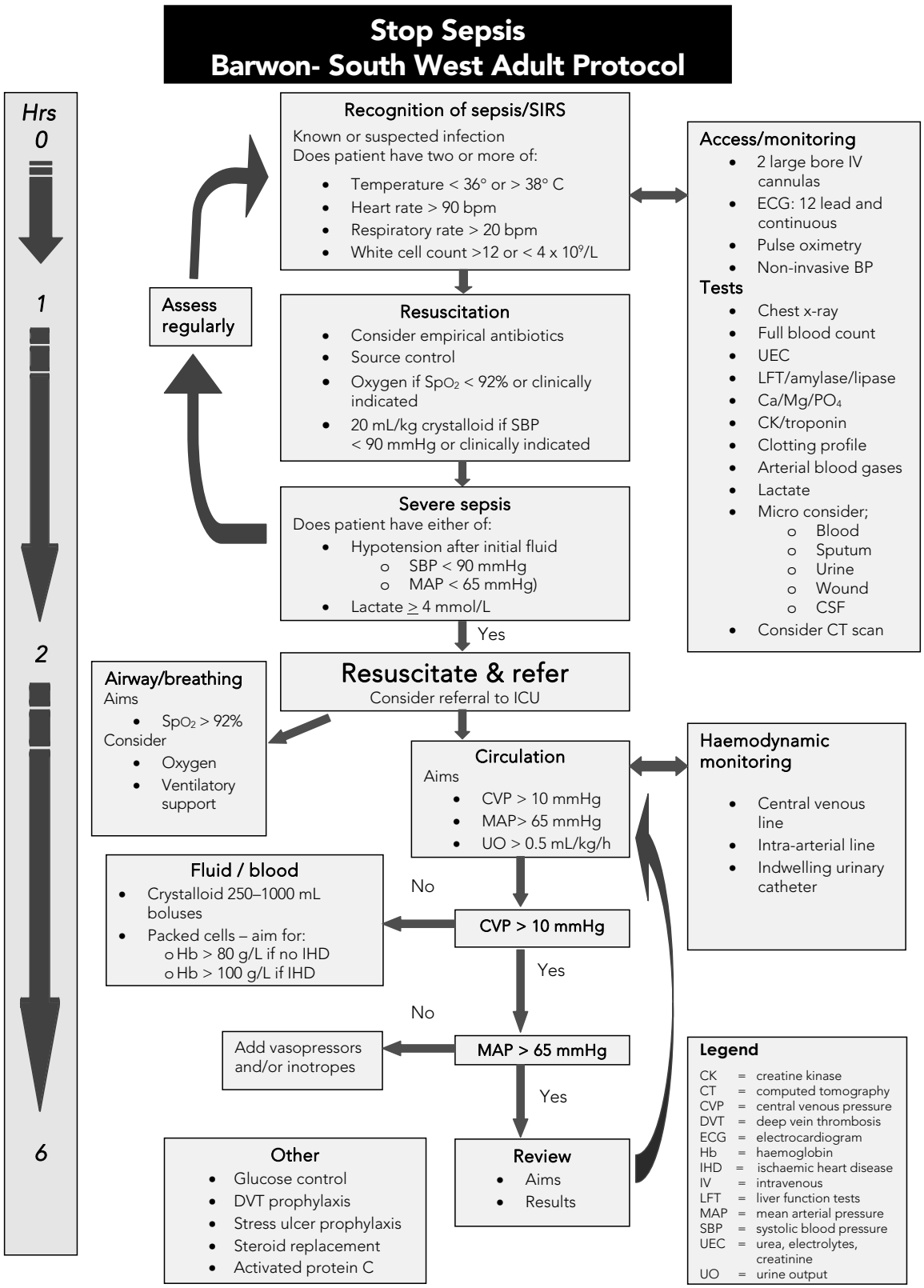
Appendix 1. Barwon–South West Health Adult Sepsis Protocol, adapted from the *Surviving Sepsis Campaign guidelines*[2]



Appendix 2. Criteria for sepsis and SIRS

Introduction

Sepsis is a clinical syndrome that complicates severe infection, characterised by systemic inflammation leading to microvascular perfusion abnormalities and organ dysfunction.

Definitions[12]

Infection: A microbial phenomenon characterised by an inflammatory response to the presence of microorganisms or the invasion of normally sterile host tissue by those organisms.

Systemic inflammatory response syndrome (SIRS): The presence of two or more of the following:

- Temperature > 38° C or < 36° C
- Heart rate > 90 per min
- Respiratory rate > 20 per min or $PaCO_2$ < 32 mmHg
- White cell count < 4×10^9/L or > 12×10^9/L.

Sepsis: SIRS with infection as underlying cause.

Severe sepsis: Sepsis and organ dysfunction, hypoperfusion or hypotension. Hypoperfusion and perfusion abnormalities may include, but are not limited to, lactic acidosis, oliguria, or an acute alteration in mental state.

Septic shock: Sepsis with hypotension, despite adequate fluid resuscitation, along with the presence of perfusion abnormalities. Patients who are on inotropic or vasopressor agents may not be hypotensive at the time that perfusion abnormalities are measured.

Hypotension: Systolic blood pressure (SBP) < 90 mmHg or a reduction in SBP > 40 mmHg from baseline, or mean arterial blood pressure < 65 mmHg.

Appendix 3. ICD-10 AM* codes used to define sepsis and corresponding diagnoses

ICD code	Diagnosis
A40.0	Sepsis due to streptococcus, group A
A40.1	Sepsis due to streptococcus, group B
A40.2	Sepsis due to streptococcus, group D
A40.3	Sepsis due to *Streptococcus pneumoniae*
A40.8	Other streptococcal sepsis
A40.9	Streptococcal sepsis, unspecified
A41.0	Sepsis due to *Staphylococcus aureus*
A41.1	Sepsis due to coagulase-negative staphylococcus
A41.2	Sepsis due to unspecified staphylococcus
A41.3	Sepsis due to *Haemophilus influenzae*
A41.4	Sepsis due to anaerobes
A41.50	Gram-negative septicaemia
A41.51	Sepsis due to *Escherichia coli*
A41.52	Sepsis due to *Pseudomonas*
A41.58	Sepsis due to other gram-negative organisms
A41.8	Other specified sepsis
A41.9	Sepsis unspecified, septicaemia
A01.0	Typhoid fever
A02.1	*Salmonella* sepsis
A32.7	*Listeria* sepsis
A39.4	Meningococcaemia, unspecified
A48.1	Legionnaires disease
A48.3	Toxic shock syndrome
A54.8	Other gonococcal infections
A78	Q fever
B37.7	Candidal sepsis

* ICD-10 AM = International Classification of Diseases, 10th revision, Australian modification.