

New sepsis definition changes incidence of sepsis in the intensive care unit

James N Fullerton, Kelly Thompson, Amith Shetty, Jonathan R Iredell, Harvey Lander, John A Myburgh and Simon Finfer on behalf of the Australian and New Zealand Intensive Care Society Clinical Trials Group and The George Institute for Global Health

Sepsis lacks pathognomonic clinical features and a definitive biochemical or histological diagnostic test.¹ As a result, since 1992, diagnosis of sepsis has been based on the presence of two or more of the criteria characterising the systemic inflammatory response syndrome (SIRS) (Table 1) arising from suspected or proven infection.²

In response to data questioning this construct,³⁻⁷ new criteria redefining sepsis, based on the Sequential Organ Failure Assessment (SOFA) score, have been proposed: Sepsis-3⁸ (Table 1). The epidemiological and clinical implications of adopting these new criteria are currently unknown. We aimed to estimate the impact of adopting SOFA-based diagnostic criteria for sepsis on the diagnosis and apparent mortality of sepsis in Australian and New Zealand intensive care units.

Methods

Study design and population

We conducted post hoc analyses of prospectively collected data from the point prevalence program (PPP) of the Australian and New Zealand Intensive Care Society Clinical Trials Group, which

Table 1. Definitions of sepsis

SIRS criteria for sepsis (1992)

Suspected infection *and* at least two of:

- core temperature
 - ▶ > 38°C or
 - ▶ < 36°C
- heart rate > 90 beats per minute
- respiratory rate
 - ▶ > 20 breaths per minute or
 - ▶ $P_{aCO_2} < 32$ mmHg or
 - ▶ mechanical ventilation for an acute process
- white blood cell count
 - ▶ > $12 \times 10^9/L$ or
 - ▶ < $4 \times 10^9/L$ or
 - ▶ > 10% immature neutrophils.

Sepsis-3 SOFA criteria for sepsis (2016)

Suspected infection *and* acute change in SOFA score* of ≥ 2 points consequent to infection (see eTable 1 in Appendix online).

SIRS = systemic inflammatory response syndrome. SOFA = Sequential Organ Failure Assessment. * Baseline SOFA score was assumed to be 0 in patients not known to have pre-existing organ dysfunction.

ABSTRACT

Objective: To estimate the impact of adopting the proposed new diagnostic criteria for sepsis, based on Sequential Organ Failure Assessment (SOFA) criteria, on the diagnosis and apparent mortality of sepsis in Australian and New Zealand intensive care units.

Design, setting and participants: A two-stage, post hoc analysis of prospectively collected ICU research data from 3780 adult patients in 77 Australian and New Zealand ICUs on 7 study days, between 2009 and 2014.

Main outcome measures: The proportion of patients who were diagnosed with sepsis using the criteria for systemic inflammatory response syndrome (SIRS) and who met the SOFA criteria for sepsis, and the proportion of patients who were admitted to the ICU with a diagnosis consistent with infection, who met either, both or neither sets of criteria for sepsis; comparison of the demographic differences and in-hospital mortality between these groups.

Results: Of 926 patients diagnosed with sepsis on a study day using SIRS criteria, 796/923 (86.2% [95% CI, 84.0%–88.5%]) satisfied the SOFA criteria. In-hospital mortality was similar in these groups, with death recorded for 216/872 patients (24.8% [95% CI, 21.9%–27.8%]) who met the SIRS criteria for sepsis, and for 200/747 patients (26.8% [95% CI, 23.6%–30.1%]) who met both the SIRS and SOFA criteria for sepsis. Of 122 patients meeting the SIRS criteria but not the SOFA criteria, 16 (13.1% [95% CI, 7.7%–19.1%]) died. Of 241 patients admitted with an infective condition and complete data, 142 (58.9% [95% CI, 52.4%–65.2%]) satisfied the SIRS criteria for sepsis and 210 (87.1% [95% CI, 82.2%–91.1%]) satisfied the SOFA criteria. Of the 241 patients, 99 (41.1%) were not classified as having sepsis on the study day by SIRS criteria and, of these, 80 (80.8%) met the SOFA criteria.

Conclusions: Adopting the SOFA criteria will increase the apparent incidence of sepsis in patients admitted to the ICU with infective conditions without affecting the mortality rate. Prospective evaluation of the effect of adopting the new definition of sepsis is required.

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consisted of data from single-day point prevalence studies conducted regularly in a large proportion of Australian and New Zealand ICUs. All patients present in participating ICUs at 10 am on 7 PPP study days between 2009 and 2014 were included. In this dataset, patients were contemporaneously diagnosed with sepsis if they had a presumed or proven infection and satisfied two or more criteria for SIRS. We assessed this cohort to calculate the proportion who would also satisfy the Sepsis-3 SOFA criteria.

We also analysed the cohort of patients who were admitted to the ICU within the 48 hours before data collection and whose principal reason for ICU admission was an infective condition (see eBox 1, in Appendix online at cicm.org.au/Resources/Publications/Journal). We used this cohort to calculate how many patients would satisfy the SOFA criteria even if they did not satisfy the SIRS criteria.

We obtained ethics approval for data collection and use annually at each participating hospital.

Data and statistical analysis

We calculated SOFA scores for patients from the worst recorded values on each study day. We made no assumptions about pre-existing organ dysfunction and assumed a baseline SOFA score of 0 (see Methods and eTable 1 in Appendix).^{9,10} When data were missing, we excluded the patients from the analysis and reduced the denominator accordingly. We made no assumptions about missing data.

The proportion of patients diagnosed with sepsis using SIRS criteria and SOFA criteria were calculated, along

with their relative in-hospital mortality. We compared the demographic characteristics of patients determined to have sepsis, based on SOFA criteria, using *t* tests. As there is no gold standard for the diagnosis of sepsis, we did not calculate sensitivity or specificity for either set of diagnostic criteria. We quantified agreement between the criteria using Cohen’s kappa. Because the patient groups selected using the new and old criteria were not independent, we did not calculate *P* for the comparison of in-hospital mortality, but drew inferences from the 95% confidence intervals (CIs).

We show data as means and standard deviations, or frequencies and percentages with 95% CIs, as appropriate. CIs of proportions and Cohen’s kappa were calculated using Prism 6 (GraphPad), and *t* tests were performed in SPSS Statistics, version 21.0 (IBM). We defined statistical significance as *P* < 0.05.

Results

Of 3754 patients, 926 (24.7%) were diagnosed with sepsis on a study day, using SIRS criteria, and 796/923 also satisfied the SOFA criteria (86.2% [95% CI, 84.0%–88.5%]) (Figure 1). Patients meeting the sepsis diagnostic criteria for both the SIRS and SOFA definitions were significantly older than patients meeting SIRS criteria alone (SOFA score < 2) (mean age, 59.8 years [SD, 17.0 years] v 53.0 years [SD, 19.6 years]; *P* < 0.003) (Table 2). Patients meeting both sets of sepsis diagnostic criteria also had higher Acute Physiology and Chronic Health Evaluation (APACHE) II scores for severity of disease than patients meeting SIRS criteria alone (mean APACHE II score, 21.6 [SD, 7.5] v 17.8 [SD, 7.5]; *P* < 0.001). In-hospital mortality was similar in patients identified as having sepsis by SIRS criteria alone and those meeting both SIRS and SOFA criteria: 216/872 (24.8% [95% CI, 21.9%–27.8%]) v 200/747 (26.8% [95% CI, 23.6%–30.1%]). In comparison, only 16/122 patients (13.1% [95% CI, 7.7%–19.1%]) meeting the SIRS but not the SOFA criteria died.

A total of 1591 patients were admitted to the ICU in the 48 hours before PPP data collection. Of these, 244 (15.3%)

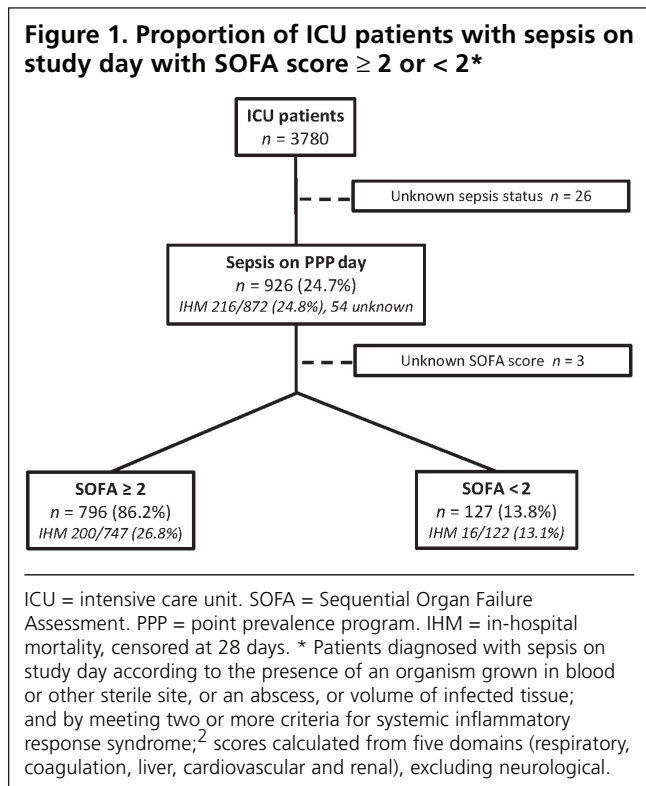


Table 2. Characteristics of patients with sepsis on study day, by SOFA score

Characteristic	SOFA score	
	≥ 2 (n = 796)	< 2 (n = 127)
Mean age, years (SD)	59.8 (17.0)	53.0 (19.6)
Male, n (%)*	508 (63.8%)	82 (63.1%)
Mean APACHE II score (SD)	21.6 (7.5)	17.8 (7.5)
Hospital mortality at Day 28, n (%)*	200 (26.8%)	16 (13.1%)

SOFA = Sequential Organ Failure Assessment. APACHE = Acute Physiology and Chronic Health Evaluation. * Proportion of patients with recorded outcome.

had an admission diagnosis indicating infection, of whom 142/241 were determined to have sepsis on the study day, based on the SIRS criteria (58.9% [95% CI, 52.4%–65.2%]) (Figure 2). In comparison, 210/241 had sepsis as defined by the Sepsis-3 SOFA criteria (87.1% [95% CI, 82.2%–91.1%]). Patients with a SOFA score ≥ 2 were older (mean age, 62.9 years [SD, 16.6 years] v 56.4 years [SD, 21.7 years]; $P = 0.168$) with significantly higher disease severity (mean APACHE II score, 19.7 [SD, 7.1] v 13.2 [SD, 6.6]; $P < 0.001$) than those with a SOFA score < 2 (Table 3).

In-hospital mortality was equivalent in patients classified as having sepsis by the SIRS or SOFA criteria (28/135; 20.7% [95% CI, 14.2%–28.6%] v 40/198; 20.2% [95% CI, 14.8%–26.5%]). Of the 99/241 patients (41.1%) not classified as having sepsis on a study day by SIRS criteria, 80/99 patients (80.8%) had a SOFA score ≥ 2 on the study day. We found poor agreement between the diagnostic criteria ($\kappa = 0.12$ [95% CI, 0.02–0.22]).

Patient characteristics, by study day, are shown in eTable 2 in the Appendix.

Discussion

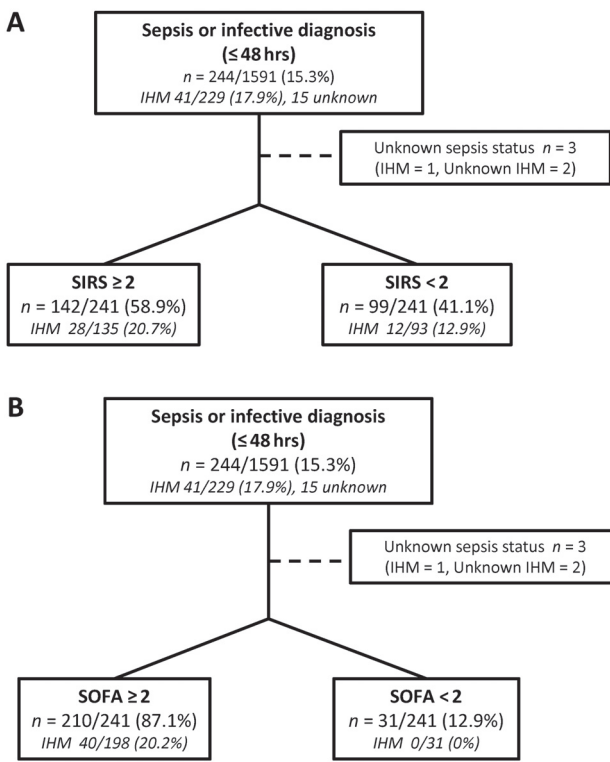
Our data suggest that adopting the Sepsis-3 diagnostic criteria will increase the number of ICU patients diagnosed with sepsis. Of patients admitted to the ICU with an admission diagnosis consistent with infection, substantially more patients will satisfy the new SOFA criteria than the existing SIRS criteria. The in-hospital mortality rate of patients diagnosed with sepsis in the ICU will be unaffected, whether the SIRS or SOFA criteria are used.

Implications of findings

The aim of the new SOFA-based criteria is to provide a pragmatic tool capable of distinguishing individuals with infection at high risk of adverse outcomes from those with self-limiting, “uncomplicated” infections, which the SIRS criteria cannot achieve.^{11,12} Our data show that although the reported mortality rate from sepsis will be unaffected, patients with infective conditions at lower risk of in-patient death who would previously have been diagnosed with sepsis using the SIRS criteria would be excluded from the diagnosis of sepsis using the SOFA criteria. This is in accordance with prior studies showing that the SOFA score has a high predictive value for mortality in ICU cohorts.^{13,14}

A recent, large, observational study by Kaukonen and colleagues reported that about 10% of ICU patients with

Figure 2. Proportion of ICU patients with admission diagnosis consistent with sepsis or infection (≤ 48 hours since admission) meeting SIRS (A) and SOFA (B) diagnostic criteria*



ICU = intensive care unit. SIRS = systemic inflammatory response syndrome. SOFA = Sequential Organ Failure Assessment. IHM = in-hospital mortality, censored at 28 days. APACHE = Acute Physiology and Chronic Health Evaluation. * Patients in the Australian and New Zealand Intensive Care Society point prevalence program registry admitted within 48 hours before data collection, with an APACHE II primary diagnosis consistent with sepsis or infection (see eBox 1 in Appendix online), were divided into patients meeting ≥ 2 or < 2 SIRS criteria.¹⁷ Within each group, the proportions of patients meeting the new criteria for sepsis (SOFA score ≥ 2) and not meeting them (SOFA score < 2) were calculated. Outcome was calculated as a proportion of individuals with an infective admission diagnosis overall and patients meeting the current definition of sepsis (≥ 2 SIRS criteria) or or not meeting it (< 2 SIRS criteria). SOFA scores were calculated from five domains (respiratory, coagulation, liver, cardiovascular and renal), excluding neurological.

Table 3. Characteristics of patients with admission diagnosis of infection admitted within 48 hours before study day, by SOFA score

Characteristic	SOFA score	
	≥ 2 (n = 210)	< 2 (n = 31)
Sepsis on study day, n (%)	130 (61.0%)	12 (38.7%)
Mean age, years (SD)	62.9 (16.6)	56.4 (21.7)
Male, n (%)	125 (58.7%)	18 (58.1%)
Mean APACHE II score (SD)	19.7 (7.1)	13.2 (6.6)
Hospital mortality at Day 28, n (%)*	40 (20.2%)	0

SOFA = Sequential Organ Failure Assessment. APACHE = Acute Physiology and Chronic Health Evaluation. * Proportion of patients with recorded outcome.

severe sepsis may not be diagnosed with sepsis (and thus “missed”) by the established SIRS criteria.⁷ The increased proportion of patients with infective conditions diagnosed with sepsis using SOFA criteria, compared with SIRS criteria, along with the low in-hospital mortality rate in patients with a SOFA score ≤ 2 , suggests that these patients are captured by the Sepsis-3 definition. It is currently unknown whether this improved sensitivity may be at the cost of reduced specificity.

The low level of agreement (kappa) observed between the SIRS and SOFA criteria suggests that the Sepsis-3 definition may identify a different patient cohort to the existing criteria. Our data show that this population will be older and sicker (with higher APACHE II scores). The clinical repercussions of designating only patients with infection and established organ failure as having sepsis remain unknown. The mortality of the patients not identified as having sepsis using SOFA criteria may increase if the absence of a diagnosis of sepsis leads to delayed or less intense monitoring and treatment. Further, the implementation of early warning detection systems based on the SIRS criteria, with treatment bundles, has been shown to lead to an enhanced process of care for patients with sepsis in New South Wales. These improved processes were associated with improvements in outcome, including reduced mortality.¹⁵ It is unclear whether integration of the new SOFA-based diagnostic criteria into these algorithms will lead to comparable performance, or whether they will be useful for the early detection of clinical deterioration from non-infective conditions.¹⁶

Strengths and weaknesses

The PPP data represent binational data from self-selected ICUs participating on a voluntary basis. The data are collected prospectively by trained research nurses and coordinators, many of whom have collected data for this program for many years; this suggests that the data are of high quality and the study is of high integrity.

Post hoc analysis inevitably restricts interpretation of the data. The proportion of patients meeting the SOFA-based definition was not collected as a primary data point. Hence, the proportion of patients with SIRS-negative, SOFA-positive sepsis had to be inferred from patients admitted within 48 hours before a study day, with an admission diagnosis consistent with sepsis or infection. Additionally, as the SOFA score before a study day was not collected, differentiating between patients with an acute increase in SOFA score of ≥ 2 (meeting the new definition of sepsis) and those with a chronically elevated SOFA score of ≥ 2 (not meeting the definition) was not possible. Further, the SOFA scores in the neurological domain were not recorded. Their inclusion could only have increased the reported number of patients diagnosed with sepsis using the SOFA criteria. Mortality status was not known for 5% of patients.

Our estimated mortality rate for patients who did not meet the new criteria for sepsis may be an underestimate. These patients could have received additional monitoring and treatment, which would not have occurred without the diagnosis of sepsis. The true outcome of individuals who meet the SIRS criteria but not the SOFA criteria can only be determined prospectively.

Conclusion

Using SOFA-based sepsis diagnostic criteria defines an older patient population with higher disease severity. Retrospectively applying SOFA diagnostic criteria to Australian and New Zealand ICUs increased the number of ICU-treated patients diagnosed with sepsis without altering the apparent in-hospital mortality rate.

Acknowledgements

James Fullerton and Kelly Thompson collated, analysed and interpreted the data. James Fullerton, Kelly Thompson and Amith Shetty drafted the manuscript. Simon Finfer conceived the study, interpreted the data and oversaw manuscript preparation and revision. James Fullerton and Kelly Thompson had full access to the data and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to and approved the final version of the manuscript.

Competing interests

None declared.

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Appendix

This appendix was part of the submitted manuscript and has been peer reviewed. It is posted as supplied by the authors.

Supplementary Online Content

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New Sepsis Definition changes the incidence of sepsis in patients admitted to the Emergency Department and the Intensive Care Unit.

eMethods	Calculation of Sequential Organ Failure Assessment (SOFA) score and in-hospital mortality
eBox 1	Cohort definition
eTable 1	SOFA scoring algorithm
eTable 2	Patient characteristics by study day
eTable 2	Australian and New Zealand Intensive Care Society Clinical Trials Group Point Prevalence Program participating sites, Principal Investigators and Research Co-ordinators

eMethods

Calculation of SOFA score

We reviewed contemporaneously collected SOFA scores in patients diagnosed with sepsis on an ANZICS CTG PPP study day; the diagnosis was made if a defined focus of infection was identified and the patient had ≥ 2 SIRS criteria (eBox 1). Scores were calculated from 5 SOFA domains; respiratory ($\text{PaO}_2/\text{FiO}_2$), coagulation, liver, cardiovascular, renal, using the most deranged score in the 24-hour study period (eTable 1). Patients with an unknown value in any domain were excluded. Where a domain was recorded as not measured the score was assumed to be zero. As we did not capture information on specific preexisting organ dysfunction we assumed all patients to have a baseline SOFA score of zero.

To explore the proportion of patients with infection and < 2 SIRS criteria who would satisfy the new diagnostic criteria for sepsis in the ANZICS CTG PPP registry, we extracted SOFA scores from data collected on study day in patients with an APACHE III ICU admission diagnosis indicating sepsis or infection who had been admitted to the ICU in the 48-hours preceding the PPP day (eBox 1).

Calculation of In-Hospital Mortality

In-hospital mortality was employed as the primary outcome measure. Data were collected from clinical notes and electronic medical record review after discharge from hospital. In-hospital mortality was censored at 28 days after study day.

eBox 1. Cohort Definition

1. Sepsis on study day defined as a focus of infection indicated by the presence of both:
 - a. The presence of ≥ 2 SIRS criteria
 - b. An organism grown in blood or other sterile site or an abscess or volume of infected tissue (e.g. fecal peritonitis)
2. Infective diagnosis as either;
 - a. APACHE III admission diagnosis of sepsis;
 - i. Sepsis (other than urinary tract infection)
 - ii. Sepsis of urinary tract origin
 - iii. Sepsis with shock (other than urinary tract infection)
 - iv. Sepsis with shock of urinary tract origin
 - b. APACHE III admission diagnosis consistent with infection;
 - i. Non-operative; Pneumonia, parasitic pneumonia, bacterial pneumonia, viral pneumonia, gastrointestinal tract perforation, gastrointestinal tract obstruction, neurologic infection, cellulitis or soft tissue infection
 - ii. Post-operative; respiratory infection, gastrointestinal tract perforation or rupture, cholecystitis or cholangitis, fistula or abscess surgery, peritonitis, cellulitis or soft tissue infection

eTable 1: Sequential Organ Failure Assessment (SOFA)¹ Score*

Organ System	Score				
	0	1	2	3	4
Respiratory: PaO ₂ /FiO ₂ ^a mmHg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support ^b	<100 (13.3) with respiratory support
Renal: Creatinine (μmol/l) Urine output ^c (ml / day)	< 110	110 – 170	171 – 299	300 – 440 or < 500	> 440 or < 200
Liver: Bilirubin (mg/dl)	< 1.2	1.2 – 1.9	2.0 – 5.9	6.0 – 11.9	≥ 12.0
Cardiovascular: Hypotension Inotropes/vasoconstrictors (μg / kg / minute)‡	MAP ≥ 70 mmHg	MAP <70 mmHg	Dopamine ≤ 5 or any dose dobutamine, milrinone or levosimendan	Dopamine 5.1 – 15 or epinephrine ≤ 0.1 or norepinephrine ≤ 0.1	Dopamine > 15 or epinephrine > 0.1 or norepinephrine > 0.1
Coagulation: Platelets (x 10 ³ /μL)	≥150	< 150	< 100	< 50	< 20
Central Nervous System**: Glasgow Coma Scale Score	15	13–14	10–12	6–9	<6

*Respiratory support defined as any form of invasive or non-invasive ventilation including mask CPAP or CPAP delivered through a tracheostomy/tracheotomy or endotracheal tube.

Catecholamine doses are given as μg / kg / minute for at least 1 hour.

**GCS was not collected and therefore excluded from calculation of total SOFA scores.

eTable2: PPP Characteristics by study day								
Month(s)/Year of Study Day	May-June 2009	Dec-Feb 2009/10	Nov-Dec 2010	Sept - Oct 2011	Nov-Dec 2012	Nov-Dec 2013	Sep-Oct 2014	Overall 2009-2014
Total Sites – no.	48	39	46	44	38	31	49	
Patient Characteristics								
All patients – no.	682	566	507	511	472	397	645	3780
Age years - mean± SD	60.0±18.1	59.8±16.5	58.8±17.2	58.1±17.9	59.6±18.0	58.7±17.3	59.8±17.6	59.3±17.6
Male sex – no. (%)	418(61.3)	359(63.4)	327(64.5)	315(61.6)	303(64.2)	243(61.2)	386 (59.8)	2351(62.2)
APACHE II - mean± SD	18.6±7.9	18.5±7.7	17.3±7.2	18.6±8.0	18.3±7.7	18.4±7.4	18.3±8.7	18.4±12.5
Sepsis on study day* - no. (%)	168(24.6)	135 (23.9)	119 (23.5)	151 (29.5)	102(21.6)	99(24.9)	152 (23.6)	926(24.5)
Admission diagnosis of Infection – no. (%)	141(20.6)	99(17.4)	102(20.1)	100(19.6)	118(25.0)	98(24.7)	150(23.2)	808(21.4)
Admission diagnosis of infection & admitted within 48 hours prior to study day - no. (%)	39 (5.7)	19 (3.3)	32 (6.3)	22 (4.3)	42 (9.1)	37 (9.3)	53 (8.2)	244

* Sepsis on study day as defined in eBox 1; The presence of ≥2 SIRS criteria and an organism grown in blood or other sterile site or an abscess or volume of infected tissue

**Australian and New Zealand Intensive Care Society Clinical Trials Group
Point Prevalence Program participating sites, Principal Investigators and
Research Co-ordinators**

Point Prevalence Study Day 1 – 6th May and 3rd June 2009

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Imogen Mitchell	Elise Crawfoot Rebecca Ashley
Blacktown Hospital	Graham Reece	Treena Sara
Calvary Mater Newcastle	Katrina Ellem	Katrina Ellem
Concord Hospital	David Milliss	Helen Wong
Gosford Hospital	Rob Cameron	Sheridan Hatter
John Hunter Hospital	Peter Harrigan	n/a
Liverpool Hospital	Michael Parr Yashesh Palliwal	Sharon Micallef
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt
North Shore Private Hospital	Anthony Delaney	Sharon Ash Dena-Louise Hogben
Prince of Wales Hospital	Yahya Shehabi	Frances Bass Victoria Stockdale
Royal North Shore Hospital	Rakesh Rai Simon Finfer	Susan Ankers Anne O'Connor Julie Potter
Royal Prince Alfred Hospital	David Gattas	Dorrilyn Rajbhandari
St George Hospital	Prof John Myburgh	Vanessa Dhiacou
St Vincent's Hospital, Sydney	Priya Nair	Claire Burns Claire Reynolds
Westmead Hospital	Ashoke Bannerjee	Christina Skelly
Wollongong Hospital	Martin Sterba	Renee Xu
Royal Darwin Hospital	Dianne Stephens	Jane Thomas
Auckland City Hospital (CVICU/HDU)	Rachael Parke	Vicki Cocharne
Auckland DCCM	Colin McArthur	Lynette Newby Catherine Simmonds
Christchurch Hospital	Seton Henderson	Jan Mehrtens
Hawke's Bay Hospital	Ross Freebairn	Liesley Chadwick
Middlemore Hospital	Tony Williams	Judi Tai Anna Tilsley
Wellington Regional Hospital	Dick Dinsdale	Diane Mackle Lynn Andrews
Gold Coast Hospital	Brent Richards	Mandy Tallott Rosemary Whitebread
Mater Health Services	Jeff Presneill John Morgan	Joanne Sutton Kylie Gregory
Princess Alexandra Hospital	Chris Joyce	Meg Harward

Royal Brisbane & Women's Hospital	Rob Boots	Paul Jarrett
Toowoomba Hospital	Benjamin Cheung	n/a
Townsville Hospital	Geoff Gordon	Leonie Jones
Flinders Medical Centre	Santosh Verghese	Elisha Ryan
Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Tricia Williams
Royal Hobart Hospital	David Cooper	Rick McAllister
Alfred Hospital	Andrew Davies	Shirley Vallance Victoria Bennett
Austin Health Hospital	Rinaldo Bellomo	Glenn Eastwood Leah Peck
Bendigo Hospital	Jason Fletcher	Julie Smith
Box Hill Hospital	David Ernest	Suzanne Elliott
Cabrini Hospital	Felicity Hawker	Felicity Hawker
Epworth Eastern	n/a	Samuel Ho
Frankston Hospital	John Botha	Jodi Vuat David Lewis
Geelong Hospital	Claire Cattigan	Melissa Fraser Tania Elderkin
Monash Medical Centre	Craig Walker	Pauline Galt
Northern Hospital	Graeme Duke	Mary Park
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith
Western Health	Craig French	Heike Raunow
Fremantle Hospital	David Blythe	AnneMarie Palermo
Royal Perth Hospital	Steve Webb	Geraldine McEntaggart Jenny Chamberlain
Sir Charles Gardiner Hospital	Stuart Baker	Brigit Roberts
St John of God Hospital	Steve Webb	n/a

Point Prevalence Study Day 2 – 9th December 2009 and 3rd February 2010

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Imogen Mitchell	Elise Crawfoot
Blacktown Hospital	Graham Reece	Treena Sara
Calvary Mater Newcastle	Katrina Ellem	Katrina Ellem
Concord Hospital	David Milliss	Helen Wong
Gosford Hospital	Rob Cameron	Sheridan Hatter
John Hunter Hospital	Peter Harrigan	none
Liverpool Hospital	Michael Parr Benoj Varghese	Sharon Micallef
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt
North Shore Private Hospital	Anthony Delaney	Sharon Ash Dena-Louise Hogben
Prince of Wales Hospital	Yahya Shehabi	Frances Bass Victoria Stockdale
Royal North Shore Hospital	Rakesh Rai Simon Finfer	Susan Ankers Anne O'Connor Julie Potter Simon Bird
Royal Prince Alfred Hospital	David Gattas	Dorrilyn Rajbhandari
St George Hospital	Prof John Myburgh	Deborah Inskip Rebecca Sidoli
St Vincent's Hospital, Sydney	Priya Nair	Claire Burns Claire Reynolds
Westmead Hospital	Ashoke Banerjee	Christina Skelly
Wollongong Hospital	Martin Sterba	Renee Xu
Royal Darwin Hospital	Dianne Stephens	Jane Thomas
Auckland City Hospital (CVICU/HDU)	Rachael Parke	Vicki Cocharne
Auckland DCCM	Colin McArthur	Lynette Newby Catherine Simmonds
Christchurch Hospital	Seton Henderson	Jan Mehrtens
Wellington Regional Hospital	Dick Dinsdale	Diane Mackle Lynn Andrews
North Shore Hospital - NZ	Janet Liang	Jeanette Bell
Gold Coast Hospital	Brent Richards	Mandy Tallott Rosemary Whitebread
Mater Health Services	Jeff Presneill John Morgan	Joanne Sutton Kylie Gregory
Princess Alexandra Hospital	Chris Joyce	Meg Howard
Royal Brisbane & Women's Hospital	Rob Boots	Paul Jarrett
Townsville Hospital	Geoff Gordon	Leonie Jones
Prince Charles Hospital	Prof. John Fraser	Naomi Hammond Amanda Corley
Flinders Medical Centre	Santosh Verghese	Elisha Ryan

Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Tricia Williams
Royal Hobart Hospital	David Cooper	Rick McAllister
Alfred Hospital	Andrew Davies	Shirley Vallance Victoria Bennett
Austin Health	Rinaldo Bellomo	Glenn Eastwood Leah Peck
Bendigo Hospital	Jason Fletcher	Julie Smith
Box Hill Hospital	David Ernest	Suzanne Elliott
Geelong Hospital	Claire Cattigan	Tania Elderkin Allison Bone Melissa Fraser Tania Salerno
Northern Hospital	Graeme Duke	Mary Park
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith
Western Health	Craig French	Heike Raunow
Royal Perth Hospital	Steve Webb	Geraldine McEntaggart Jenny Chamberlain
Sir Charles Gardiner Hospital	Stuart Baker	Brigit Roberts

Point Prevalence Study Day 3 – 17th November 2010 and 15th December 2010

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Imogen Mitchell	Helen Rodgers Rebecca Ashley Elisha Fulton
Calvary Hospital	Katrina Ellem	Katrina Ellem
Concord Hospital	David Milliss	Helen Wong
Gosford Hospital	Rob Cameron Sean Kelly	Sheridan Hatter
Liverpool Hospital	Michael Parr Saradha Srinivasan	Sharon Micallef
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt
North Shore Private Hospital	Anthony Delaney	Sharon Ash Dena-Louise Hogben
Royal Prince Alfred Hospital	David Gattas	Dorrilyn Rajbhandari Heidi Buhr
St George Hospital	John Myburgh Manoj Saxena	Jennene Miller Rebecca Sidoli Deborah Inskip
St Vincent's Hospital, Sydney	Priya Nair	Claire Reynolds
Westmead Hospital	Vineet Nayyar	Christina Skelly Jing Kong
Wollongong Hospital	Martin Sterba	Bronwyn Johnson
Macquarie Hospital	Michael Parr	Deepak Bhonagiri
Royal Darwin Hospital	Dianne Stephens	Jane Thomas Michelle Fletcher
Auckland City Hospital	Rachael Parke	Eileen Gilder Jodi Brown
Auckland DCCM	Colin McArthur Catherine Simmonds	Lynette Newby Catherine Simmonds
Christchurch Hospital	Seton Henderson David Knight	Jan Mehrrens
Hawke's Bay Hospital	Ross Freebairn	Liesley Chadwick
Middlemore Hospital	Tony Williams	Judi Tai Anna Tilsley Chantel Hogan
Wellington Regional Hospital	Dick Dinsdale	Diane Mackle Lynn Andrews
North Shore Hospital - NZ	Janet Liang	Umit Holland
Tauranga Hospital	Troy Browne Rachel Atkin	Jennifer Goodson
Gold Coast Hospital	Brent Richards	Mandy Tallott
Townsville Hospital	Geoff Gordon	Leonie Jones Stephen Reeves
Flinders Hospital	Santosh Verghese	Elisha Ryan,

Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Tricia Williams Catherine Kurenda
Royal Adelaide Hospital	Marianne Chapman	Stephanie O'Connor Alison Ankor
Royal Hobart Hospital	David Cooper	Rick McAllister
Alfred Hospital	Andrew Davies	Shirley Vallance Jasmin Board
Austin Hospital	Rinaldo Bellomo	Glenn Eastwood Leah Peck
Box Hill Hospital	Inga Mercer	Japreet Sidhu
Geelong Hospital	Claire Cattigan	Tania Elderkin Allison Bone Melissa Fraser Tania Salerno
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith Jennifer Holmes
Dandenong Hospital	Sanjiv Vij	Bridget O'Bree Kate Shepherd
Albury Hospital	Charles Mashonganyika	Clare Maher Elizabeth Ibrom
Royal Perth Hospital	Steve Webb	Jenny Chamberlain
Sir Charles Gardiner Hospital	Stuart Baker	Brigit Roberts

Point Prevalence Study Day 4 – 21st September and 19th October 2011

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Imogen Mitchell	Helen Rodgers Rebecca Ashley
Calvary Mater Newcastle	Katrina Ellem	Katrina Ellem
Concord Hospital	David Milliss	Helen Wong
John Hunter Hospital	Peter Harrigan	Miranda Hardie
Liverpool Hospital	Michael Parr Anders Aneman Swapnil Pawar	Sharon Micallef
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt
Royal North Shore (Private) Hospital	Anthony Delaney	Sharon Ash Dena-Louise Hogben
Royal Prince Alfred Hospital	David Gattas	Dorrilyn Rajbhandari Heidi Buhr Jodie Cowell Liarna Honeysett
St George Hospital	Prof John Myburgh Manoj Saxena	Jennene Miller Rebecca Sidoli Deborah Inskip
St Vincent's Hospital, Sydney	Priya Nair	Claire Reynolds
Westmead Hospital	Vineet Nayyar	Christina Skelly Jing Kong
Wollongong Hospital	Martin Sterba	Bronwyn Johnson
Macquarie Hospital	Michael Parr	Deepak Bhonagiri
Royal Darwin Hospital	Dianne Stephens	Jane Thomas Michelle Fletcher
Auckland City Hospital CVICU/HDU	Rachael Parke	Eileen Gilder Jodi Brown
Auckland DCCM	Colin McArthur Lynette Newby	Lynette Newby Catherine Simmonds
Christchurch Hospital	Seton Henderson and David Knight	Jan Mehrstens
Hawke's Bay Hospital	Ross Freebairn	Liesley Chadwick
Middlemore Hospital	Tony Williams	Judi Tai Anna Tilsley Chantel Hogan
Wellington Regional Hospital	Dick Dinsdale	Diane Mackle Lynn Andrews
North Shore Hospital - NZ	Janet Liang	Umit Holland
Tauranga Hospital	Troy Browne Rachel Atkin	Jennifer Goodson
Gold Coast Hospital	Brent Richards	Mandy Tallott
Princess Alexandra Hospital	Chris Joyce	Georgina Sexton
Toowoomba Hospital	Indranil Chatterjee	Judy Smith
Townsville Hospital	Geoff Gordon	Leonie Jones

		Stephen Reeves
Nambour General Hospital	Peter Garrett	Anne Buckley Shona McDonald Loretta Forbes
Robina Hospital	Robin Holland Yogesh Apte Alan Lim	
Flinders Medical Centre	Santosh Verghese	Elisha Ryan Amy Waters
Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Tricia Williams Catherine Kurenda
Royal Adelaide Hospital	Marianne Chapman	Alison Ankor Stephanie O'Connor Justine Rivett
Royal Hobart Hospital	David Cooper	Rick McAllister
Alfred Hospital	Andrew Davies	Shirley Vallance Jasmin Board
Austin Health	Rinaldo Bellomo	Glenn Eastwood Leah Peck Helen Young
Box Hill Hospital	Inga Mercer	Japreet Sidhu
Geelong Hospital	Claire Cattigan	Tania Elderkin Allison Bone Melissa Fraser Tania Salerno
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge Andrea Jordan Elizabeth Moore
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith
Western Health	Craig French	Samantha Bates
Dandenong Hospital	Sanjiv Vij	Bridget O'Bree Kate Shepherd
Central Gippsland Health Service	Jenny Dennett & Howard Connor	Tim Coles
Ballarat Health Services		Dianne Hill
Maroondah Hospital	David Charlesworth	Jaspreet Sidhu
Royal Perth Hospital	Steve Webb	Jenny Chamberlain
Sir Charles Gardiner Hospital	Stuart Baker	Brigit Roberts

Point Prevalence Study Day 6 – 13th November and 13th December 2012

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Imogen Mitchell	Helen Rodgers Elisha Fulton
Calvary Mater Newcastle	Katrina Ellem	Suzanna Vale
Concord Hospital	David Milliss	Helen Wong
John Hunter Hospital	Peter Harrigan	Miranda Hardie
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt
North Shore Private Hospital	Anthony Delaney	Sharon Ash Dena-Louise Hogben
Royal North Shore Hospital	Prof Simon Finfer	Frances Bass Naomi Hammond Anne O'Connor Elizabeth Yarad Simon Bird
Royal Prince Alfred Hospital	David Gattas	Heidi Buhr Megan Keir
St George Hospital	John Myburgh Manoj Saxena	Jennene Miller Rebecca Sidoli Deborah Inskip
Westmead Hospital	Vineet Nayyar	Christina Skelly Jing Kong
Wollongong Hospital	Martin Sterba	Bronwyn Johnson Wenli Geng
Macquarie University Hospital	Michael Parr	Deepak Bhonagiri
Auckland City Hospital (CVICU/HDU)	Rachael Parke	Eileen Gilder Lianne McCarthy
Auckland DCCM	Colin McArthur Lynette Newby	Kirsten Benefield Yan Chen
Christchurch Hospital	Seton Henderson David Knight	Jan Mehrrens Sascha Noble
Hawke's Bay Hospital	Ross Freebairn	Liesley Chadwick
Middlemore Hospital	Tony Williams	Anna Tilsley Chantel Hogan Rima Song Laura Rust
Waikato Hospital	Rob Frengley	Mary La Pine John Durning
Wellington Regional Hospital	Dick Dinsdale	Lynn Andrews Diane Mackle Jessica Ongley
North Shore Hospital - NZ	Janet Liang	Jeanette Bell Danni Hacking
Tauranga Hospital	Troy Browne Rachel Atkin	Jennifer Goodson
Gold Coast Hospital	Brent Richards	Mandy Tallott

Flinders Medical Centre	Santosh Verghese	Elisha Ryan
Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Tricia Williams Kathy Kurenda
Royal Adelaide Hospital	Stephanie O'Connor	Helen McBeth Justine Rivett
Royal Hobart Hospital	David Cooper	Rick McAllister
Austin Health	Rinaldo Bellomo	Glenn Eastwood Leah Peck Helen Young
Bendigo Hospital	Jason Fletcher	Julie Smith
Geelong Hospital	Claire Cattigan	Tania Elderkin Allison Bone Melissa Fraser Tania Salerno
Northern Hospital	Graeme Duke John Green Andrew Casamento	Mary Park Olga Burgess
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge Andrea Jordan
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith Jennifer Holmes
Western Health	Craig French	Samantha Bates
Albury Hospital	Charles Mashonganyika	Clare Maher
Central Gippsland Health Service	Jenny Dennett Howard Connor	Tim Coles
Royal Perth Hospital	Steve Webb	Jenny Chamberlain
Sir Charles Gardiner Hospital	Stuart Baker	Brigit Roberts

Point Prevalence Study Day 7 – 7th November and 11th December 2013

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Sean Chan	Helen Rodgers Amy Harney Katie Milburn
Concord Hospital	David Milliss	Helen Wong
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt Anne Ritchie Maria Nikas Rebecca Gresham
North Shore Private Hospital	Anthony Delaney	Dena-Louise Hogben Laura Davies
Prince of Wales Hospital	Yahya Shehabi	Nicola Straiton
Royal North Shore Hospital	Simon Finfer	Frances Bass Naomi Hammond Anne O'Connor Elizabeth Yarad Simon Bird
St George Hospital	John Myburgh Manoj Saxena	Jennene Miller Rebecca Sidoli Deborah Inskip
St Vincent's Hospital, Sydney	Priya Nair	Serena Knowles
Westmead Hospital	Vineet Nayyar	Christina Skelly Jing Kong
Wollongong Hospital	Martin Sterba	Bronwyn Johnson Wenli Geng
Auckland City Hospital	Rachael Parke	Eileen Gilder Lianne McCarthy Rachael Parke
Auckland DCCM	Colin McArthur Lynette Newby	Lynette Newby Yan Chen
Christchurch Hospital	Seton Henderson David Knight	Jan Mehtens
Middlemore Hospital	Tony Williams	Chantal Hogan Tony Williams
Waikato Hospital	Rob Frengley	Mary La Pine John Durning
Wellington Hospital	Dick Dinsdale	Lynn Andrews Sally Hurford Anna Hunt
North Shore Hospital (Auck)	Janet Liang	Jeanette Bell Danni Hacking
Tauranga Hospital	Troy Browne Rachel Atkin	Jennifer Goodson
Flinders Medical Centre	Santosh Verghese	Elisha Matheson Kate Schwartz

Lyell McEwin Hospital	Rajaram Ramadoss	Josette Wood
The Queen Elizabeth Hospital	Sandra Peake	Catherine Kurenda JoAnne McIntrye
Royal Adelaide Hospital	Stephanie O'Connor	Sonya Kloeden Justine Rivett
Austin Hospital	Rinaldo Bellomo	Glenn Eastwood Leah Peck Helen Young
Bendigo Hospital	Jason Fletcher	Julie Smith
Cabrini Hospital	Jonathan Barrett	Gabrielle Hanlon
Geelong Hospital	Claire Cattigan	Tania Salerno Allison Bone Tania Elderkin
The Northern Hospital	Angaj Ghosh John Green Andrew Casamento	Mary Park Olga Burgess
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge Andrea Jordan
St Vincent's Hospital, Melbourne	John Santamaria	Roger Smith Jennifer Holmes
Western Health	Craig French	Samantha Bates
Albury Hospital	Charles Mashonganyika	Clare Maher

Point Prevalence Study Day 8 – 24th September and 22 October 2014

Intensive Care Unit	Principal Investigator/s	Research Co-ordinator/s
Canberra Hospital	Frank van Haren	Helen Rodgers Rebecca Millar Mary Nourse
Calvary Mater Newcastle	Katrina Ellem	Katrina Ellem
Concord Hospital	David Milliss	Helen Wong
Gosford Hospital	Rob Cameron	Katrina Ellis
John Hunter Hospital	Peter Harrigan	Miranda Hardie
Liverpool Hospital	Michael Parr	Sharon Micallef
Nepean Hospital	Ian Seppelt	Leonie Weisbrodt Anne Ritchie Maria Nikas Rebecca Gresham
North Shore Private Hospital	Anthony Delaney	Dena-Louise Hogben Joanna Hallam
Royal North Shore Hospital	Simon Finfer	Elizabeth Yarad Anne O'Connor Simon Bird Frances Bass Naomi Hammond
Royal Prince Alfred Hospital	David Gattas	Heidi Buhr Debra Hutch
St George Hospital	John Myburgh	Jennene Miller Rebecca Sidoli Deborah Inskip
St Vincents, Sydney	Priya Nair Hergen Buscher	Serena Knowles Claire Reynolds
Westmead Hospital	Ashoke Banerjee Vineet Nayyar	Christina Skelly Jing Kong
Wollongong Hospital	Martin Sterba	Bronwyn Johnson Wenli Geng
Macquarie Hospital	Deepak Bhonagiri Anders Aneman	Victor Tam
Orange	Karen Smith	Caroline Laurie Leanne Casey
Bathurst	Anne Morrison	
St Vincents' Private, Sydney	Sam Rudham	Claire Reynolds Anita Maitra Megan Joyce
Royal Darwin Hospital	Dianne Stephens	Jane Thomas
Auckland DCCM	Colin McArthur	Lynette Newby
Christchurch Hospital	Seton Henderson David Knight	Jan Mehtens
Auckland CVICU	Rachael Parke	Eileen Gilder Lianne McCarthy

Hawke's Bay Hospital	Ross Freebairn	Liesley Chadwick
Middlemore Hospital	Tony Williams	Anna Tilsley
Waikato	Annette Forrest	Mary La Pine John Durning
Wellington Hospital	Dick Dinsdale	Lynn Andrews Sally Hurford Anna Hunt Diane Mackle
North Shore Hospital - NZ	Danni Hacking	Danni Hacking
Tauranga Hospital	Troy Browne	Jennifer Goodson Julia Braid
Dunedin Hospital	Sam Rudham	Robyn Hutchison
Nelson Hospital	Bruce King	Jill Norton Joy Tomlinson Robyn Price
Rotorua Hospital	Ulrike Buehner	Erin Williams
Gold Coast Hospital	Brent Richards	Jody Paxton
Princess Alexandra	Chris Joyce	Jason Meyer
Townsville		Stephen Reeves Fiona Whaley
Mackay Base Hospital	Neeraj Bhadange	
Nambour	Peter Garrett	Anne Buckley Loretta Forbes
Flinders Medical Centre	Santosh Verghese	Elisha Matheson Kate Schwartz
Lyell McEwin Hospital	Peter Thomas	Natalie Soar
Queen Elizabeth Hospital	Sandra Peake	JoAnne McIntyre
Royal Adelaide Hospital	Stephanie O'Connor	Justine Rivett
Austin Hospital	Rinaldo Bellomo	Glenn Eastwood Leah Peck Helen Young
Bendigo Hospital	Jason Fletcher	Julie Smith
Box Hill	David Charlesworth	Andrea Doric
Cabrini	Jonathan Barrett	Gabrielle Hanlon
Northern Hospital	Angaj Ghosh	Mary Park Olga Burgess
Royal Melbourne Hospital	Christopher Macisaac	Deborah Barge Andrea Jordan
St Vincents, Melbourne	John Santamaria	Jennifer Holmes Roger Smith
Western Health	Craig French	Samantha Bates Anna Tippett
Maroondah Hospital	David Charlesworth	Andrea Doric
Royal Perth	Ed Litton	Lizzie Jenkinson
Sir Charles Gairdner Hospital	Stuart Baker Paul Woods	Brigit Roberts

	Katherine Creeper	
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References:

1. Vincent, J.L., et al., The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. *Intensive Care Med*, 1996. **22**(7): p. 707-10.