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BLOOD STREAM INFECTION (BSI) DEFINITION

Please note that the "Introduction to National Guidelines for Surveillance" must be read in conjunction with this document.

PREAMBLE

The 2003 *National Strategy to Address Health Care Associated Infections* developed by the Australian Council for Safety and Quality in Health Care¹, suggests that blood stream infections (BSIs) may be costing Australia up to \$686 million each year. The Strategy also reports that up to half of these infections can be prevented. Traditionally, preventative infection control measures are most appropriately implemented when valid and reliable supporting information exists.

BSI rates should be calculated using patient groups exposed to similar risks of BSI as the denominator. The definitions in this module are proposed to assist Infection Control Practitioners (ICPs) to target BSIs among specific patient populations including patients undergoing procedures, dialysis, haematology, intensive care, or oncology unit patients. As there is wide variation in device utilisation and case mix among hospitals, appropriate risk adjustment is difficult.

Hospitals should regard all health care associated BSIs as events (signal infections) that require timely investigation for preventable factors and documentation of corrective actions taken².

KEY POINTS

- The definitions are designed for the purposes of infection surveillance; not diagnosis. They are not designed to identify all infections but are designed to flag problem areas requiring further detailed investigation.
- Comparison of infection rates between institutions is not recommended. They should be used for the purposes of implementing appropriate interventions to improve the quality of care; not for external benchmarking.
- These definitions exclude neonates and neonatal intensive care units. Surveillance of neonatal sepsis should be carried out using a stand-alone neonatal infection surveillance program.

INTRODUCTION

These definitions for BSI surveillance are modified from the National Nosocomial Infections Surveillance System (NNIS) from Centre for Disease Control (CDC) Atlanta, USA³ and from the Public Health Laboratory Service of the UK (PHLS)⁴ recommendations so that they include the focus or primary site of infection and place of acquisition of infection, the intention being to extend the reach of health care associated infection surveillance beyond just patients in hospitals. With regard to intravascular (IV) catheter-associated blood stream infection, the definition is identical to the NNIS laboratory confirmed (primary) blood stream infection (LCBI).

It is recognised that these definitions may often require some clinical assessment of patients to maintain the validity of this indicator because laboratory surveillance without clinical correlation is often inaccurate (e.g. To assess whether a low virulence bacteria such as *Staphylococcus epidermidis* is a “contaminant” or a “significant” isolate). This view is incorporated into the recommended definitions.⁵ It is also recommended that the site of collection (i.e., peripheral blood or intravascular line collection) be recorded to assist Clinicians with interpretation of results.

Health care associated blood stream infections are often infrequent events, particularly in smaller institutions. Because of the potential for severe consequences, each incident should be investigated further as a “signal infection”² to ensure that institutional practices and procedures are appropriately being carried out to minimise the occurrence of these infections.

This document is divided into the following sections:

1. Definition of Blood Stream Infections (BSIs)
2. Definition of the Place of Acquisition (i.e., Health care associated, Community-associated, Maternally-acquired)
3. Definition of the Focus of Infection (i.e., unknown, line-associated, organ site focus, neutropenic sepsis)
4. Recommended Denominators for Surveillance Rate Determinations

1. DEFINITION OF BLOOD STREAM INFECTION

A blood stream infection must meet the conditions in one (1) of the following criteria:

Criterion 1 (recognised pathogens; non neonatal intensive care)

Isolation of one or more recognised bacterial or fungal pathogens from one or more blood cultures (e.g., *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli*, *Klebsiella*, *Proteus*, *Salmonella* species, *Candida albicans*).

Note: Where mixed isolates are obtained with one being an accepted pathogen, the potential contaminant^p organism is to be disregarded.

Criterion 2 (potential contaminants^b in patients aged >1 year)

The patient has at least one of the following signs and symptoms within 24 hours of a positive blood culture being collected:

Fever (>38°C);
Chills or rigors; or
Hypotension

and

at least one of the following:

- a. there is isolation of the same potential contaminant^b from two (2) or more blood cultures drawn on separate occasions within a 48 hour period (isolates identified by suitable microbiological techniques)
- b. there is isolation of a potential contaminant^b from a single blood culture drawn from a patient with an intravascular line (within 48 hours of the episode) and appropriate antimicrobial therapy against that isolate is commenced.

Criterion 3 (potential contaminants^b in patients aged <1 year not including neonates)

The patient has at least one of the following signs and symptoms within 24 hours of a positive blood culture being collected:

fever (>38°C);
hypothermia (<36°C); or
apnoea or bradycardia

and

at least one of the following:

- a. there is isolation of a potential contaminant^b from two (2) or more blood cultures drawn on separate occasions within a 48 hour period.
- b. there is isolation of a potential contaminant^b from a single blood culture drawn from a patient with an intravascular line (within 48 hours of the episode) and appropriate antimicrobial therapy is commenced.

Notes:

- a. A blood stream infection due to the same organism(s) that recurs within 14 days of the original event is disregarded and not counted as a new episode as it is considered to be the same infection.
- b. Potential contaminant organisms include coryneforms (*Corynebacterium*, etc.), coagulase-negative staphylococci, micrococci, *Propionibacterium*, *Bacillus*, alpha haemolytic streptococci, environmental Gram-negative bacilli, non-pathogenic *Neisseria*.
- c. If antimicrobials are given for less than 14 days for a dialysis access line-associated infection and then restarted for the same infection, this is NOT considered a new incident. However, if IV antimicrobials are stopped for 14 days or more and then restarted for a BSI with the same organism, this is considered a new episode.

2. PLACE OF ACQUISITION (HEALTHCARE-ASSOCIATED / COMMUNITY ASSOCIATED / MATERIALLY ACQUIRED)

Each BSI episode is categorised by place of probable acquisition as follows:

A. Health care associated event satisfies at least one (1) of the following criteria:

- a. acquired during hospitalisation and not present or incubating on admission;
- b. is a complication of the presence of an indwelling medical device (e.g., IV catheter, urinary catheter);
- c. occurs within thirty days of a surgical procedure, where the bloodstream infection is related to the Surgical Site Infection;
- d. an invasive instrumentation or incision related to the bloodstream infection was performed within 48 hours before onset of the infection. If the time interval was longer than 48 hours, there must be compelling evidence that the infection was related to the invasive device or procedure; or
- e. associated with neutropænia (<1 ×10⁹/L) contributed to by cytotoxic therapy.

Health care associated events are then subcategorised as being either:

Non-inpatient associated

OR

Inpatient-associated

*Inpatient events are those that occur more than 48 hours after hospital admission or within 48 hours of discharge.

B. Community-associated

These events are when the episode is:

not health care associated

and

manifests within 48 hours after admission unless an organism with a long incubation period (e.g., *Salmonella* Typhi) is isolated.

and are **not** maternally-acquired (see below)

C. Maternally-acquired

This is an infection in a neonate that is acquired from the mother during delivery.

Unless strong evidence suggests otherwise, an infection that appears less than 48 hours after birth is considered to be acquired from the mother.

For the purpose of surveillance and subsequent investigations, maternally acquired BSIs should be included in the facility's neonatal sepsis surveillance program, as the factors associated with neonatal BSIs are similar to those associated with other forms of sepsis (e.g., meningitis) and need to be analysed as a group distinct from other forms of health-care or community associated BSIs.

3. FOCUS OF INFECTION

Each BSI episode is classified by focus or principal site of the infection. Three categories are recommended:

- a. *Unknown focus*, (this includes disseminated infections such as those caused by *Neisseria meningitidis*)
- b. *Intravascular catheter-associated bloodstream infection*

This requires an intravascular catheter to be present within 48 hours of the episode.

and

The organism(s) must not be related to an infection at another site.

- c. *Organ site focus*. This category is to be used when, at the time of presentation there is clinical or bacteriological evidence that the infection arose from a specific organ site. It is suggested that the organ sites be categorised into systems or anatomical areas as listed below. The presence of a non-intravascular device or occurrence of a procedure that is considered to be a contributing factor to the episode should be recorded as a sub category (see below). These sites are as follows:

- Urinary tract
- Respiratory tract
- Gastrointestinal (includes gastroenteritis, enterocolitis, peritonitis and other intra-abdominal sources other than liver and biliary tract)
- Bone and joint
- Hepatobiliary
- Skin and soft tissue
- Genital tract
- Central nervous system
- Head and neck
- Cardiovascular (includes endocarditis, arterial or venous infection, myocarditis, pericarditis and mediastinitis)
- Other

To help determine the site that best describes the focus for each episode, the use of the published NNIS definitions from CDC are recommended⁵. However, criteria for diagnosis of infection related to each site are not well defined for all sites by the NNIS definitions. Thus designation of the focus of infection will also require a degree of clinical judgement.

Additional Information that Should be Collected:

Non-intravascular Device associated BSIs

When a device (other than an intravascular device) or prosthesis is present (eg Cerebro Spinal Fluid (CSF) shunt, prosthetic joint) at the suspected organ site focus within 48 hours of the BSI and there is compelling clinical or microbiological evidence that it is the focus or source of the infection, the presence of that device should be recorded.

Procedure-associated BSIs

For each BSI where an organ site focus is identified, it may be recorded whether an invasive medical, surgical or anaesthetic procedure (e.g., Endoscopic Retrograde Cholangiopancreatography (ERCP), arthroscopy etc.) within 48 hours (or within 30 days if an surgical site infection (SSI) is the focus) of the event was a significant contributing factor. If the time interval was longer than 48 hours (or 30 days for an SSI), there must be compelling evidence that the BSI was related to the procedure.

Neutropænic sepsis

Defined as a BSI occurring in a patient with a neutrophil count less than 1×10^9 /L (1000/mm³). Because the majority of these patients have an indwelling intravascular cannula, and no clinically apparent organ site focus, the source is usually attributed as line associated sepsis. This potentially leads to a high number of false positive categorisations of line associated sepsis in this group. The source in this group is usually unknown, but thought to be the mucositis caused by chemotherapeutic drugs. Patients who are neutropænic should be stratified into a separate category of neutropænia related BSI and analysed as a subgroup for the relevant source of infection unless there is strong evidence that an intravascular catheter is the source of the sepsis (e.g., a positive catheter tip culture with the same organism as the blood culture). Neutropænic patients with clinical mucositis and no other clinical focus should have the infection site designated as the gastrointestinal site

4. Denominators for Blood Stream Infection (BSI)

BSI rates should be calculated using patient groups exposed to similar risks of BSI as the denominator. As there are wide variations in device utilisation and case mix among hospitals, appropriate risk adjustment is difficult. Therefore, external benchmarking of hospital wide indicator rates for BSI is no longer recommended. Hospitals should regard all healthcare associated BSIs as events (signal infections) that require timely investigation for preventable factors and documentation of corrective actions taken².

A broad denominator for non-central line associated BSIs such as 1000 occupied bed days or 1000 separations could be considered for reporting BSIs internally to place them into perspective within the organisation. These rates cannot be used for interhospital comparison due to the large potential range of compounding factors.

Central Line Associated BSIs (CLAB)

Central line associated BSIs (CLAB) in intensive care units (ICUs), haematology, oncology and home intravenous therapy units are recommended as the numerator for indicator BSI rates. Days of exposure to central line devices ('central line days') comprise the most important risk factor for infection and, therefore, where possible, are used as the denominator for rate calculation.

Peripherally-inserted (PI) central lines have significantly lower infection rates than centrally-inserted (CI) lines. For each unit, stratification of events and denominators into these two categories is recommended. Hence separate calculations should be made for PI and CI-inserted central lines.

When calculating 'central line days', all types of central lines (cuffed and non-cuffed, peripherally inserted central catheter (PICC) etc) *in situ* in a specific unit during the period of surveillance are included. Where possible, central line types should be identified and then infection episodes stratified by line type.

Intensive Care Units

Numerator

This is all CLABs that occur 48 hours or more after admission to ICU. Events that occur within 48 hours of discharge from ICU should also be included in the numerator. This requires that all inpatient associated BSI events be reviewed to determine whether a BSI may have been related to a recent ICU admission.

Denominator

The recommended denominator is central line days. The method of collecting this data can either be a system for tracking all insertions and removals or a tally system⁷. In the latter system, regular surveys of all unit patients are made, counting the number of patients that have a central line *in situ* and the number without such lines. Patients with two central lines are counted once only. It is not necessary to perform the tallies on every day of the month. In larger units, a statistically valid sample can be obtained by counting on 3-5 days of each week. At the end of the month, the overall proportion of patients with a central line is calculated to determine the central line utilisation ratio. This, multiplied by the total unit inpatient days for the month, yields the total number of central line days. Note that no allowance is to be made for line days that accrue after discharge from the ICU. Separate tallies and calculations are made for CI and PI central lines.

Central Line Associated BSI Rate:

$$\frac{\text{Number of CLAB during a specified surveillance period}}{\text{Number of central line days measured for that same surveillance period}} \times 1000$$

The companion indicator that should also be noted during each surveillance period is the:

Central Line Utilisation Ratio (CLUR) (%):

$$\frac{\text{Number of central line days during a specified surveillance period}}{\text{Number of patient days during the same period}} \times 100$$

General Notes

Stratification into PI-central lines and CI-central line BSI rate and CLUR is recommended.

Haematology and Oncology Units

Numerator

The numerator should be all health care associated CLAB. Inpatient and outpatient associated events are to be combined. Note that ACHS current surveillance requirements are for inpatient episodes only, however, patients are often discharged with long term catheters *in situ*, and healthcare associated episodes frequently occur outside hospital, and should be noted for review accordingly.

Denominator

The recommended denominator is central line days. It is recommended that this be calculated by tracking all central line insertions and removals and combining the total number of days *in situ*. This enables stratification of central line infection rates by central line type, which may help to identify the specific location of a problem.

Central Line Associated BSI Rate:

$$\frac{\text{Number of CLAB during a specified surveillance period}}{\text{Number of central line days measured for that same surveillance period}} \times 1000$$

Stratification into PI-central line and CI-central line BSI rate is recommended.

Outpatient Intravenous Therapy Units

Numerator

The recommended numerator is all unit associated CLAB.

Denominator

The recommended denominator is central line days. It is recommended that this be calculated by tracking of all central line insertions and removals and combining the total days *in situ*. This has the added advantage of enabling stratification of line infection rates by line type. This may help with identifying the location of a problem if a particular line type is associated with a high rate. It also enables detection of significant line management issues such as mechanical failure or blockage.

Central Line Associated BSI Rate:

$$\frac{\text{Number of CLAB during a specified surveillance period}}{\text{Number of central line days measured for that same surveillance period}} \times 1000$$

General Notes

Outpatients are those patients managed in the community or on a hospital outpatient basis who are receiving treatment (i.e., antibiotics, total parenteral nutrition (TPN)) via a central line and who are not already included in BSI rate calculations in another unit i.e., haematology/oncology.

Stratification into PI-central line and CI-central line BSI rate is recommended.

The use of denominators such as “occupied bed days” or “total number of patients with lines inserted” instead of “central line days” may lead to significant bias when comparison of sequential time periods is attempted. They may be useful as a “global” description of the CLAB situation in a facility as they place these types of infection into a readily understandable context. It should be acknowledged in reports if these rate types are used.

Haemodialysis Access-Associated BSI⁸

Haemodialysis associated BSI is defined as a BSI in a patient receiving haemodialysis without an organ site focus for the BSI where there is clinical infection at the site of vascular access.

Dialysis Unit - Access associated BSI

Numerator

Blood Stream Infection in a patient undergoing haemodialysis

Either local access site infection OR no identifiable organ site focus

Denominator

Rates per 100 patient months

These should then be stratified by vascular access type.

Vascular access types are:

- Graft
 - Synthetic (e.g., Poly Tetra Fluoro Ethylene (PTFE), Thoratec)
 - Native vein
- Fistula
- Temporary catheter (non-cuffed)
- Permanent Catheter (cuffed)

BSI rate associated with haemodialysis:

$$\frac{\text{Number of Dialysis Associated BSI during a specified surveillance period}}{\text{Number of dialysis patient months measured for that same surveillance period}} \times 100$$

1

General Notes

Rates should be calculated separately for each type of vascular access.

The denominator is simply calculated by counting the number of patients being haemodialysed each month and adding them together.

For example, if there were 45 patients in January, 40 in February and 50 in March, the denominator would be (45+40+50=135) 135 dialysis patient months for the 3 month surveillance period. If a patient was on the Dialysis program for only 1 or 2 weeks, fractional calculations can be made and given values of 0.25 or 0.5.

The denominator should then be subdivided (stratified) by dialysis access device as stated above.

If antimicrobials are given for less than 14 days for a dialysis-access line-associated infection and then restarted for the same infection, it is NOT considered a new episode. If IV antimicrobials are stopped for 14 days or more and then restarted for a BSI, this is considered a new episode.

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