APPROACHES TO SURGICAL SITE INFECTION SURVEILLANCE

For acute care settings in Australia

May 2017

AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Published by the Australian Commission on Safety and Quality in Health Care
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ISBN: 978-1-925224-59-7

The Commission's preference is that you attribute this publication (and any material sourced from it) using the following citation:

> Australian Commission on Safety and Quality in Health Care. Approaches to Surgical Site Infection Surveillance. Sydney: ACSQHC; 2017

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1. Introduction

The Australian Commission on Safety and Quality in Health Care (the Commission) has produced this document in consultation and collaboration with technical experts from across Australia.

This document describes the approaches that can be used to underpin the design and implementation of a surgical site infection (SSI) surveillance program in acute healthcare settings. While the majority of Australian states and territories include some surgical site infection surveillance within their healthcare-associated infection (HAI) surveillance programs, most SSI surveillance is limited to hip arthroplasty, knee arthroplasty and coronary artery bypass grafts.[1] Health service organisations should consider the approaches described in this document when establishing a new SSI surveillance program and when reviewing or expanding current SSI surveillance programs. Local differences in surveillance capacity, surveillance methods and information data systems also should be considered when designing any SSI surveillance program.

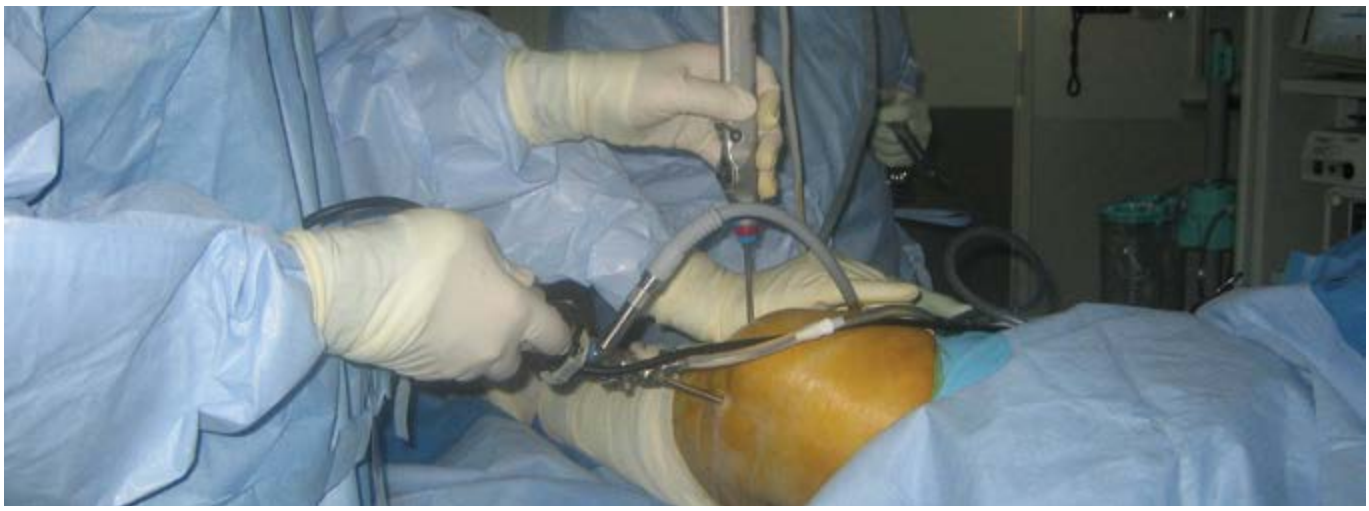
The principles described in this document are specific to the acute healthcare setting; and this document also acknowledges the importance of including those involved in post-operative care in the SSI surveillance program. Health service organisations should refer to their state or territory surveillance unit for further advice on doing SSI surveillance in non-acute healthcare settings.

1.1 State and territory resources

This document has been designed to complement state and territory SSI surveillance programs and should be used alongside local guidance and surveillance programs, where available.

Table 1: State and territory resources

State	Resources
New South Wales	Healthcare Associated Infections Clinical Indicator Manual (V2.0, 2008)
Queensland	Guideline for Surveillance of Healthcare Associated Infection Signal Infection Surveillance (2013)
South Australia	South Australia Health Infection Control Service
Western Australia	Healthcare Associated Infection Surveillance Western Australia
Victoria	Victorian Healthcare Associated Infection Surveillance System (VICNISS)



1.2 Main points

This document captures the main elements that should be considered when designing and implementing an SSI surveillance program in acute care settings in Australia.

The approaches described aim to improve the usefulness of surveillance data for measurement and priority setting at both the local and national level. The main points for health service organisations to consider are:

- A surveillance program that includes surgical site infections can provide both an immediate and a prolonged impact in reducing the rate of infection
- The SSI surveillance program needs to align with the overall goals of the health service organisation's infection prevention and control program, as well as any mandatory requirements from external agencies, such as state and territory health departments
- SSI surveillance should be approached as an interdisciplinary team activity that draws on the combined expertise of the executive, quality coordinators/advisers, nursing staff, surgeons, anaesthetists and infection prevention and control professionals. The surveillance team should work together to plan, design, implement and update the surveillance program
- When designing a SSI surveillance program, it is necessary to consider the most appropriate surveillance designs, the selection of surgical procedures for surveillance, appropriate surveillance definitions, case finding methods, and systems for capturing surveillance data, data analysis and reporting
- The SSI incidence rate is the most common measure found in SSI surveillance programs. Depending on the rationale for the local SSI surveillance program, it may be appropriate to include other additional process and/or outcome measures
- Case finding is an essential part of SSI surveillance and needs to be done thoroughly to enhance the reliability of surveillance data. Prospective case finding can be optimised through the use of multiple case-finding methods and post-discharge surveillance
- Differences between surgical procedures, patient types and clinical settings influence the likelihood of an SSI. Risk adjustment methods that control for variation due to these factors enable a more accurate comparison of surveillance data
- Once the SSI surveillance program is implemented, surveillance results should be regularly reviewed by the surveillance team, the relevant surgical teams and the organisation's executive to determine opportunities and priorities for further investigation, process change and improvement.

2. Rationale

Surgical site infection (SSI) is one of the most common complications associated with surgery.[2] In Australia, infection of the surgical site occurs in approximately 3% of surgical procedures.[3, 4] Every patient who undergoes surgery is at risk of acquiring an infection.

A patient with an SSI may need additional antimicrobial treatment, or may require further surgery, particularly if grafts or implants have been compromised, or may need to be readmitted to hospital. These all involve considerable physical and emotional burden for the patient.[5-8] Additionally, there is also a higher risk of mortality associated with SSIs, particularly among elderly patients.[9] Ensuring that there is an appropriate infection surveillance system in place will promote targeted infection control responses and better patient care outcomes.

A healthcare-associated infection (HAI) surveillance program that includes SSIs can provide both an immediate and a prolonged impact in reducing the rate of infection.[10] This occurs firstly through the collection and dissemination of robust data that can be used for comparison and benchmarking.[11] Secondly, the dissemination of surveillance data enables clinicians and hospital executives to review local circumstances and surgical outcomes and use this evidence base to motivate greater compliance with infection prevention and control measures, instigate practice change and encourage standardisation of care.[2,10]

2.1 The National Safety and Quality Health Service (NSQHS) Standards

The NSQHS Standards promote HAI surveillance activities as a means of garnering robust data on the incidence and prevalence of infection within a health service organisation. As a demonstration of compliance with the NSQHS Standards, health service organisations should use surveillance data to inform local infection prevention and control strategies.

SSI surveillance programs should be consistent with NSQHS Standard 3.2, which states that:

> The health service organisation has a surveillance strategy for HAI that:
>
> - Collects data on HAI relevant to the size and scope of the organisation
> - Monitors, assesses and uses surveillance data to reduce risks associated with HAI
> - Reports surveillance data on HAI to the workforce, the governing body, consumers and other relevant groups.

Surgical site infection surveillance following patient transfer

Hospitals that receive transferred patients post-operatively also should establish and implement an SSI surveillance program to measure and report on the incidence of SSI among these patients. The inclusion of transferred patients in surveillance will provide a better estimation of the overall prevalence of SSIs in the health system and will improve understanding of the surgical outcomes that emerge after transfer.[12]

The design of surveillance programs in these hospitals should focus on identifying and monitoring high-risk patient groups and establishing collaborative communication channels with facilities that provide surgical services. High-risk patients for these hospitals are patients who:

- Have been transferred after surgery performed elsewhere
- Have been admitted after recent surgery performed elsewhere
- Have received outpatient care after recent surgery performed elsewhere.

If an SSI is observed then the hospital should report the incident and any related results to the hospital that undertook the procedure. Reporting should occur regardless of any set surveillance follow-up periods.

3. Who needs to be involved in SSI surveillance?

It is recommended that health service organisations approach SSI surveillance as a quality improvement exercise and draw on the expertise of a range of people from across the health service organisation.

3.1 The health service organisation executive

The decision to undertake an SSI surveillance program should be made at the executive level. Executives should use information from the organisation's risk management system to inform this decision and ascertain the scope and size of the SSI surveillance program. At a minimum, the executive should seek advice from the local surgical unit(s) and the infection prevention and control service on the volume of surgical procedures undertaken in the facility, the risk of infection and clinical consequence associated with these procedures, and the availability of strong evidence-based practice guidelines or expert consensus to support practice change.

The executive is responsible for setting an organisational culture that 'promotes individual responsibility for infection prevention and control among all staff'.[13] Securing executive sponsorship of the SSI program can reinforce individual clinician accountability for patient outcomes. Executive sponsorship signifies that the program is a priority for the organisation and can be powerful in motivating behaviour change and clinical practice improvement on the clinical floor.[14]

The executive needs to regularly review the scope and results of the surveillance activities. In order to do this, surveillance results should be provided regularly to the executive and should be accompanied with an explanation of the data, the data source, the methods of data analysis and recommended actions for improvement.[15]

Executives should use information generated from the SSI surveillance program to inform the prioritisation and development of appropriate SSI prevention strategies.

3.2 Surveillance teams and personnel

Surveillance should be carried out by individuals (such as infection prevention and control professionals or orthopaedic clinical nurse specialists) who are trained in surveillance methods, including the application of surveillance definitions, data collection, data analysis, reporting and the delivery of feedback. Surveillance training should be conducted by individuals who have expertise in HAI surveillance, epidemiology, and infection prevention and control. Depending on local arrangements, these individuals may be based within the health organisation, Local Hospital Network or state and territory health departments. Individuals responsible for conducting SSI surveillance should undertake surveillance training regularly to ensure familiarity with current surveillance definitions; annual training is recommended. Theoretical understanding and practical competency should be assessed as part of surveillance training. Individuals who are responsible for undertaking data collection also need to have familiarity with the clinical workflows and the record keeping systems of the surgical unit(s).

Forming surveillance teams

The Surgical Site Infection Surveillance Service in the United Kingdom provides advice on forming an SSI surveillance team.

The establishment of a centralised surveillance unit should be considered in networks where multiple health service organisations are participating in the same SSI surveillance program. A centralised approach will support consistency and comparability across participating organisations.

3.3 Surgical teams

The surgical team can play a number of roles in a SSI surveillance program. The team can assist in data collection by:

- Identifying patients who have risk factors for SSI during the pre-surgical work-up
- Screening patients for possible SSI onset during post-surgical follow-up during the surgical admission and after discharge, where possible (that is, during outpatient clinic visits)
- Reviewing suspected SSI cases that have been identified by other members of the surveillance team
- Providing discharge summaries that detail relevant SSI risk factors.[16,17]

3.4 Primary care providers

Many primary care providers take on the responsibility of post-operative patient care; this is particularly common in regional and rural settings. Patients may have undergone surgery in a referral hospital and then transferred to the care of general practitioner or visiting medical officer at a local hospital, or been discharged home after surgery. These patients may not always attend specialist outpatient clinics post-operatively, and may rely on their primary care providers for follow-up examination and care. As a result, health service organisations should seek to include post-discharge surveillance within the broader SSI surveillance program where feasible.

Any SSI surveillance program that includes post-discharge surveillance in the primary care setting needs to include primary care providers on the surveillance team. Primary care providers should be involved in designing the post-discharge surveillance component and informing the best ways to engage primary care clinicians to collect and report data back to surgical facilities. Selecting suitable representation of primary care providers may require liaison with local Primary Health Networks.[18] Alternatively, primary care providers who are regularly attending to post-surgical patients may be suitable representatives on the surveillance team; a review of recent discharge summaries may be useful in identifying these clinicians.

Section 5.3.3 Collecting data after discharge provides further explanation of post-discharge surveillance.

3.5 Patients

Patient monitoring is a vital source of information that can be used to detect, prevent and guide the management of SSIs. Changes in a patient's clinical condition and overall health can be indicative of a potential SSI. As part of the SSI surveillance program, it is critical to engage post-surgical patients, and their carers or other support people, to report changes in their health to their clinical team or, if discharged, to their primary care provider so that timely clinical assessment and care can be undertaken and any emergent infections can be accounted as part of surveillance data collection. Strategies for enabling this sort of patient engagement need to be addressed in the design of the surveillance program. Inclusion of consumer representatives and/or former surgical patients in the surveillance team, particularly during the planning phase, may help to inform the development of patient engagement strategies that are appropriate for the local setting.

4. Surveillance designs

The most common surveillance designs for surgical site infection surveillance are:

- **Continuous surveillance** is appropriate if surveillance needs to be ongoing
- **Targeted surveillance** is necessary when surveillance needs to be time-limited or specific to a certain procedure, infection or setting
- **Process surveillance** is used when the purpose of surveillance is to measure how clinical care is delivered to the patient
- **Outcome surveillance** is used to measure whether a specific clinical endpoint has been achieved
- **Prospective** and **retrospective surveillance** designs address whether surveillance data need to be collected during or after the patient's admission.

Only prospective and retrospective surveillance designs are mutually exclusive; that is, a prospective surveillance program cannot also be a retrospective surveillance program. All other combinations of surveillance designs are valid. Therefore it is possible to have a process surveillance program that is simultaneously continuous, targeted and prospective.

4.1 Continuous surveillance

Continuous surveillance refers to the ongoing or rolling surveillance of a particular process or outcome. Ongoing daily review of microbiology results is an example of a continuous surveillance activity. Continuous surveillance is useful for establishing a baseline rate of infection and for demonstrating infection rates over a long period of time.

4.2 Targeted surveillance

Targeted surveillance focuses on a specific process or outcome in a specific population over a set period of time. Targeted surveillance is not intended to be a permanent initiative. Often it is initiated in response to a high rate of disease and after rates have been controlled surveillance activity may be ceased or limited to high risk areas.[19]

Using targeted surveillance

A targeted surveillance design is useful for monitoring:

- novel organisms
- outbreaks and epidemics
- high-risk patients or functional areas.

The Clinical Instrument Surveillance Program: Tonsillectomy in Wales uses targeted surveillance to monitor the impact of changing from single-use surgical equipment to reusable equipment on SSI rates associated with tonsillectomy.

Targeted surveillance can be undertaken alongside continuous surveillance. An example of this synergy is the targeted continuous surveillance of carbapenemase-producing *Enterobacteriaceae* in duodenoscopes.

4.3 Process or outcome surveillance

A surveillance program that specifically measures adherence with accepted guidelines, policies or standards is known as process surveillance. Process surveillance can provide evidence of whether a clinical process is occurring sub-optimally, but it does not have the ability to discriminate if a sub-optimal process has resulted in a SSI. In contrast, a surveillance program that measures an outcome (such as rate of infection) provides users with evidence that SSIs are occurring, but does not illuminate on the clinical processes that may have contributed to the SSI. Process surveillance can be done alongside outcome surveillance, or in settings where the number of SSIs captured using outcome surveillance is expected to be very low.[20]

Undertaking process surveillance is usually much easier than doing outcome surveillance. This is because process indicators are easier to measure and there is no need to perform risk adjustment (see Section 6 Risk adjustment). A surveillance program that includes process indicators may trigger immediate improvements because practice change can be readily targeted to an identified clinical process.[2] Ideal process indicators for SSI surveillance are those processes that contribute to SSI acquisition and

can be modified. Local surgical checklists and guidelines include a number of clinical processes that are suitable process measures for surveillance. The surveillance of process indicators is logistically easier than that required for outcome surveillance – it does not require specific epidemiological training and usually does not require interrogation of multiple data sources.[21] An example of a process indicator that may be considered as part of an SSI surveillance program is antibiotic prophylaxis. Antibiotic prophylaxis is recommended for a range of surgical procedures to reduce the risk of a SSI.[20] The Australian Commission on Safety and Quality in Health Care has funded the National Centre for Antimicrobial Stewardship to conduct the Surgical National Antimicrobial Prescribing Survey (sNAPS), a standard auditing tool to assist in the antimicrobial stewardship for surgical procedures.[22]

Using process and outcome surveillance together

The New Zealand Surgical Site Infection Improvement Programme is an example of a surveillance program that combines process and outcome surveillance.

4.4 Prospective surveillance

Prospective surveillance is considered as a 'best practice' surveillance method[23] and can be described as doing surveillance in 'real time' to identify cases as they emerge. A strong prospective surveillance program requires the daily collection of surgical lists, pharmacy dispensing records or results of laboratory cultures. Prospective surveillance is more resource-intensive and time-consuming compared to retrospective surveillance, yet it is considered advantageous for several reasons:

- Immediate clinical treatment and care can be rapidly initiated for any infection detected during data collection
- Appropriate infection prevention and control strategies can be implemented immediately to mitigate further transmission[24]
- Data collected from records can be verified against direct patient observations, increasing the reliability of the dataset
- Surveillance data that has been collected prospectively can be reported close to real-time, ensuring that clinicians who are involved in SSI events are aware of the event in a timely fashion.

An example of prospective surveillance

Every morning the infection control team receives a daily microbiology report from the laboratory. They review the report immediately on receipt and check for any positive cultures from surgical site wounds. The team then cross-checks recent surgical lists and the patient admission system for any patients that have returned a positive culture. If the patient is still admitted, one of the team goes down to the surgical ward before discharge rounds and does clinical interviews with post-operative patients who are possible cases to determine if the patient meets the SSI surveillance definition.

4.5 Retrospective surveillance

Retrospective surveillance refers to finding cases through a review of healthcare records and other clinical documentation.[25] Usually, review will occur at the end of the surveillance period or cycle and may occur some time after the patient's hospital admission. In retrospective surveillance, healthcare records are reviewed for documented signs or symptoms of infection that are consistent with the surveillance definition. A record review can be a very efficient way to collect surveillance data[25]; however, those responsible for collecting surveillance data are usually unable to verify documented clinical observations with their own clinical assessment as patients may have been discharged or transferred, or it may not be possible to follow up with them. Another potential drawback of retrospective surveillance is that it is heavily reliant on thorough clinical documentation being recorded during the patient's admission and such documentation is not always accurate, of high quality or available.[26-29] Incomplete or inaccurate clinical documentation can contribute to poor clinical care coordination for the patient and may diminish the usefulness of any other record linked to the healthcare record (such as clinical coding data). Poor quality clinical documentation will also hinder the ability to do comprehensive case finding and will result in inaccurate surveillance data being reported.

5. Key components of a surgical site infection surveillance program

When designing a SSI surveillance program, it is necessary to consider the most appropriate surveillance designs, the selection of surgical procedures for surveillance, appropriate surveillance definitions, case finding methods, and systems for capturing surveillance data, data analysis and reporting.

5.1 Selection of surgical procedures for surveillance

States and territories have determined a number of mandatory surgical procedures for surveillance. Refer to relevant state or territory surveillance protocols to determine which surgical procedures need to be included in the organisation's surveillance program.

The inclusion of non-mandatory surgical procedures should be determined on the basis of a risk assessment.[30] The risk assessment should consider:

- the patient/s undergoing these procedures and their susceptibility to infection
- the infection risks associated with these surgical procedures.

Choosing surgical procedures for surveillance

Common surgical procedures for surveillance include:

- total knee arthroplasty
- total hip arthroplasty
- coronary artery bypass grafting
- Caesarean section.

Other surgical procedures to consider for surveillance are:

- craniotomy
- laminectomy
- spinal fusion
- hernia repair
- colectomy
- appendectomy
- cholecystectomy.

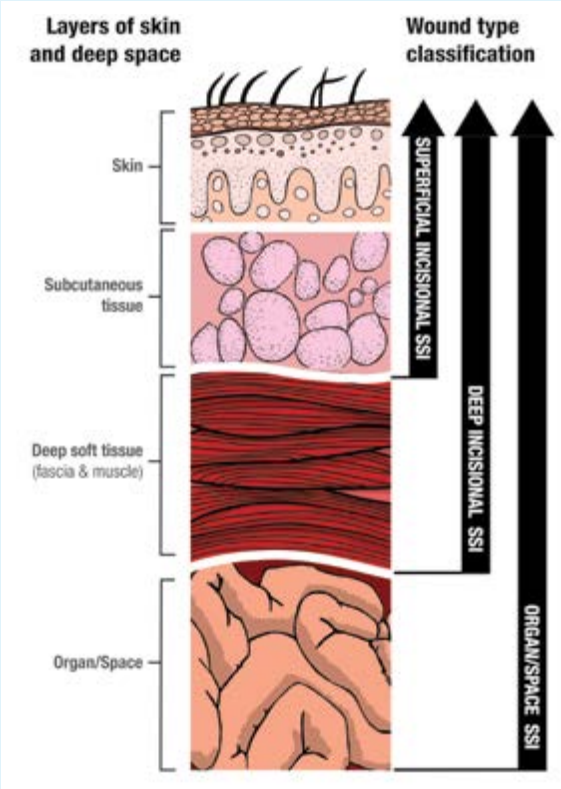
5.2 Surgical site infection surveillance definitions

A surveillance definition is essentially the criteria that are used to determine whether an infection can be attributed to a surgical procedure. Definitions are specific to the procedure that is under surveillance. For example, a definition for an SSI related to total knee arthroplasty will have different parameters to a definition that is related to a coronary artery bypass graft.

A surveillance definition is made of two parts. The first part of the surveillance definition usually describes the parameters of the numerator. In simple terms the numerator represents the number of infections that have occurred, taking into consideration:

- **Patient specific risk factors** – this refers to risk factors such as the patient's age (e.g. paediatric or adult) and co-morbidities
- **The type of surgical procedure** – this needs to be considered as there are different risks associated with different surgical procedures
- **The inclusion period** – this is the period of time in which the onset of infection must have occurred for it to be related to the surgical procedure
- **The wound type** – this refers to where the SSI is located relative to the body surface. Surgical wound types are classified as 'superficial', 'deep' or 'organ/space'
- **The acceptable markers of infection** – these are the clinical signs, symptoms and other observations which are considered to be indicative of infection.

Visualising wound type



A surgical wound can be localised within the skin, tissue, organ and organ space or across multiple layers, such as both the skin and subcutaneous tissue. The location of the wound will determine the classification of the wound.

The second part of the definition describes the parameters of the denominator. The denominator represents the total number of patients who have received selected surgical procedures during the surveillance period and are potentially at risk of infection[31], that is the infected patients plus the non-infected patients.

Most SSI surveillance programs around the world have adopted definitions from the National Healthcare Safety Network (NHSN) in the United States.[32] The benefits of using standardised definitions like the NHSN definitions include easy comparison of local data with data from other health services and organisations and greater reliability as the definitions have been validated.

Surveillance definitions

The CDC's **National Healthcare Safety Network Patient Safety Component** includes a number of SSI surveillance definitions that are relevant to acute care settings.

For mandatory jurisdictional SSI surveillance measures and advice on the local definitions, refer to state and territory surveillance protocols.

5.2.1 Calculation of the SSI rate

The most common outcome measure collected in SSI surveillance programs is the SSI rate. In Australia there is no nationally standardised SSI rate calculation. Many of the existing SSI surveillance programs use the SSI rate calculation set by the NHSN, with some local modification.[1] This section provides an overview of this SSI rate calculation.

The incidence rate of SSIs is defined as the number of new SSI infections that occur during a specific time period in a defined population. The rate (or risk) is reported as the number of SSIs per 100 procedures.

Calculating the SSI incidence rate

The SSI incidence rate can be calculated using the following formula:

$$\frac{\text{number of patients with an SSI from a specific procedure during set period}}{\text{total number of patients who have undergone specific procedure during set period}} \textbf{ X100}$$

According to the SSI incidence rate calculation, SSIs are attributed to a specific procedure under surveillance, and the facility where that procedure occurred. The numerator includes the number of SSIs attributed to the date the operation or procedure was performed, not the day the infection was identified.

When performing surveillance, hospitals will need to decide how to classify patients who undergo multiple incisions during the same surgery, and how to attribute SSIs to procedures that have secondary incision sites. Further guidance should be sought from state and territory surveillance manuals. The NHSN also provides detailed guidance on a number of clinical scenarios in the **Patient Safety Component Procedure-Associated Module for SSI**.

5.3 Collecting surveillance data

5.3.1 Case finding

Case finding during a patient's admission is done as part of prospective surveillance, whereas case finding that is done after a patient's admission is more typical of retrospective surveillance. Case finding may also be inclusive of readmissions that occur during the follow-up period. The usual follow-up periods are one year post-procedure following the insertion of an implanted device and 30 days for all other reportable procedures.

Direct daily observation of the patient post-operatively is considered to be the 'gold standard' method of case finding for SSI surveillance.[33, 34] Direct daily observation of the patient, however, is resource-intensive and may be difficult to undertake in facilities if there is a high surgical volume or if there is limited surveillance capacity available. If daily direct patient observation is not possible, existing hospital data sources can be used to identify cases and at-risk patients. For example:

- **Review surgical lists** – Which patients are at risk of an SSI because they have undergone a surgical procedure?
- **Examine pathology results** – Do any patients have an elevated leukocyte count or microbiology results indicative of infection?
- **Review pharmacy dispensing records** – Have any antimicrobial agents been dispensed to the patient for the treatment of a surgical wound infection?

Patient-derived clinical data, such as healthcare records and nursing notes, can then be used to determine whether an at-risk patient has acquired an infection. Using patient-derived data will also reduce the detection of 'false positives', identified only from pathology and pharmacy dispensing records, that is, people who have records indicative of infection but have no clinical presentation indicative of infection.[35] Examples of using patient-derived data are:

- **Interrogating the patient's chart, healthcare record and clinical care plan** – Do any patient observations indicate the onset of infection after surgery (e.g. spiked temperature, febrile illness, wound erythema or discharge)?
- **Checking if the patient has been referred to other clinical services (such as infectious diseases, clinical microbiology, and wound clinics)** – Does the referral indicate presence or possibility of a wound infection?

As a general principle, an interdisciplinary approach that utilises the clinical expertise of other members of the surveillance team or other appropriate clinicians should be used when interpreting and deciphering clinical information from data sources. It is important that cases are cross-checked and validated by other members of the surveillance team to ensure that surveillance definitions are being used correctly and interpretive biases are minimised.[16]

Adjudication panels

An **adjudication panel** is a group of clinicians who review a suspected healthcare-associated infection case together to confirm whether or not a healthcare-associated infection has occurred. Adjudication panels often make determinations based on clinical judgement and not surveillance definitions, and in turn, this introduces further inconsistency into the data collection process.[36] This practice is employed in some countries; however, it is not underpinned by strong evidence and is not recommended for Australian settings.

A combination of at least two case finding methods will result in greater reliability of the surveillance data, particularly for superficial SSIs.[37] Individual case finding methods have inherent limitations[38] and when used alone will inevitably underestimate the prevalence of SSIs. Examination of pathology results alone is insufficient for the deciphering whether an SSI has occurred, particularly with regards to superficial SSIs[34], and should always be validated against patient-derived data sources.[38] It is suggested that an initial review of pathology results be undertaken to identify which medical charts need to be subsequently reviewed.[33]

5.3.2 Collecting surveillance data directly from patients

In addition to providing usual clinical care and undertaking clinical assessments and observations, clinicians who are collecting surveillance data may directly engage with post-surgical patients during their admission as part of daily observations or clinical interviews. This sort of case finding will usually take place within a prospective surveillance program. The clinician who is collecting data may frequently ask the post-surgical patient how they are feeling after surgery, how their wound looks and whether the clinician can examine their wound. It is important for clinicians who are collecting data directly from patients to explain to patients why these questions are being asked, how frequently they will be asked and why they might be repeated.

5.3.3 Collecting data after discharge

The majority of SSI cases will be identified in the first 30 days after surgery, with fewer additional cases identified after this period.[40,41] Surveillance during the entirety of the first 30-day period can be difficult, as many patients are discharged from hospital within this period.[39,40] One way to capture cases that emerge after hospital admission is to include post-discharge surveillance in the SSI surveillance program. Similar to case finding during a patient's admission, multiple methods of case finding should also be used for post-discharge surveillance if possible.[41]

Post-discharge surveillance is very much reliant on the post-surgical patient being aware of changes in their health that may be indicative of an SSI. At the time of discharge, the patient, and their support people, should be provided with wound care information and other information relevant to their clinical care. Information on the signs and symptoms of infection and who to contact if an infection is suspected should also be included. Post-discharge surveillance data collection should not, however, rely solely on a patient's ability to self-assess or self-identify SSI criteria or symptomology.[42,43] Therefore, health service organisations undertaking post-discharge surveillance also need to consider case findings methods that leverage clinical investigation and assessment undertaken in the outpatient or primary care settings. Providers working in these other settings may not have a direct reporting obligation to the health service organisation and may see participation in post-discharge surveillance as an unnecessary work burden. The following strategies may assist health service organisations in engaging these external providers to participate in post-discharge surveillance case finding:

- Emphasise how reporting will be used to improve surgical practice, post-surgical care and, more generally, patient outcomes
- Work with external providers to develop low-burden data collection systems (for example, co-design a case assessment and report template for providers to use to submit data if a case has been identified; coordinate a monthly electronic survey to known providers to identify cases; have the surveillance team undertake regular audit of outpatient records)
- Report surveillance findings and improvement initiatives back to these providers
- Enable external providers to provide input into the ongoing development of the SSI program.

It is inherently biased to compare SSI rates between hospitals that undertake post-discharge surveillance with those that do not undertake post-discharge surveillance. Hospitals that carry out post-discharge surveillance will inevitably have higher rates of SSIs compared with those hospitals that do not carry out post-discharge surveillance. To avoid this comparison, post-discharge surveillance derived data should be reported separately to inpatient surveillance data and only used locally to drive local quality improvement. Post-discharge surveillance data should not be used for the purposes of benchmarking and/or performance monitoring.[42,44]

The benefit of post-discharge surveillance

The proportion of cases identified through post-discharge surveillance can be substantial – a study from Queensland identified that half of the SSIs associated with coronary artery bypass grafting were found through post-discharge surveillance.[3] Work undertaken in Scotland has demonstrated that post-discharge surveillance will at least double the rate of SSI detection.[40] Therefore, not undertaking post-discharge surveillance will result in a substantial underestimation of the prevalence of SSIs and will hinder the identification of prevalent infection trends.[45]

5.4 Centralised data repository

As part of an organisation's SSI surveillance program, a centralised data repository should be established. An SSI surveillance data repository may be non-automated, requiring clinical personnel to collate data from various sources and manually input data into a central repository (such as a spreadsheet or database), or automated. Non-automated systems are inexpensive to set up but are prone to transcription errors and are time-consuming to maintain.[46] An alternative solution is to use an automated system. Automated systems link into existing data repositories and, based on set algorithms, scan for features in the patient datasets that are indicative of an infection.[47] However, there are a number of limitations associated with a centralised automated system:

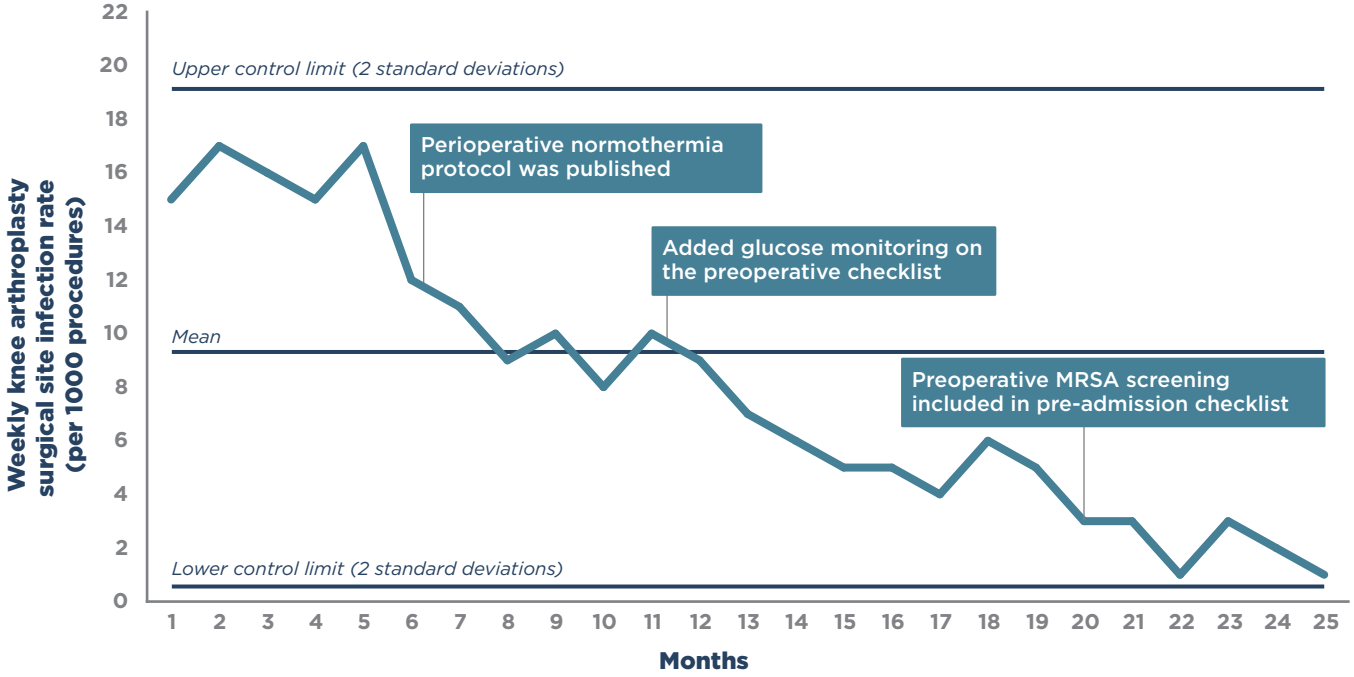
- Implementation of an automated system can be expensive and may require substantial local modification
- Technical compatibility with other data repositories (such as patient administration systems, pathology reporting systems, pharmacy dispensing records, etc.) is necessary
- The use of set algorithms will require data from other data repositories to be of high quality clinical documentation and presented in a standard format
- Clinical personnel will still need to confirm the presence of a SSI and document this observation into the automated system.[48,49]

Prior to purchasing an automated data repository, the health service organisation should consider both the benefits and the limitations of the system; the training requirements needed by system users; and, the feasibility of integration with existing data systems.

5.5 Data analysis and comparison

SSI surveillance data can be used to calculate the compliance rates for clinical processes under surveillance and the infection rate by procedure type. These rates provide a point-in-time understanding of what is currently occurring and can be compared against previous and future rates to measure trends in performance.

Figure 1: Example of a statistical process control chart for SSI rates associated with total knee arthroplasty



However, a point-in-time incidence or compliance rate does not illuminate data trends. Regular collation of point-in-time data, however, can be used to identify trends. Changes in rates over a period can be visualised by plotting rates on a statistical process control chart, also known as a run chart (See Figure 1). Data should be plotted at regular frequency (such as daily, weekly, monthly) and variations in practice should be annotated on the chart alongside the time points when the change occurred. The run chart should include an upper and a lower control limit; often control limits of three standard deviations are used. Narrower limits may be more appropriate for measures where there is a possible outcome of mortality and an earlier reaction is warranted, such as infection.[50]

5.6 Reporting

5.6.1 Internal reporting

The provision of direct feedback on performance can motivate greater compliance with infection prevention strategies among the surgical team.[10, 51] Giving direct feedback on the incidence of post-surgical infection to individual clinicians or surgical teams can be difficult, particularly as infection rates may be seen as indicative of poor clinical practice. Data should be discussed in the context of practice improvement and feedback should not be used as a means to lay blame. A post-surgical infection may emerge during convalescence, when the patient is no longer under the care of the surgical team or the hospital. The surgical team and the operating hospital may have little or no awareness that an infection has resulted from surgery if it emerged after the patient is discharged. Greater awareness of late onset infections can be improved through the collection and reporting of post-discharge surveillance data (see Section 5.3.3 Collecting data after discharge).

Feeding back surveillance results

Feedback on surveillance results can be provided to clinicians in many different ways.[52] One-on-one feedback can be provided during bedside teaching opportunities and during work performance reviews. Unit-based data can be fed back as a standing item during infection control ward rounds and departmental meetings.

Providing surgical teams with the current surveillance data is not enough. Surgical teams need to be provided with historical data in order to establish how they have been performing in the past, and data from other teams to enable comparison of performance (for example, benchmark against other surgical teams doing similar procedures). Surgical teams also need guidance on how to interpret data and coaching on how to initiate relevant quality improvement activities and sustain practice changes that are relevant to the surveillance outcome.[30]

Surveillance data needs to be fed back in way that is relevant to the individual surgical team. This can be done by contextualising their performance and providing recognition of good performance and areas for improvement.[15] In particular, surgical teams working in large facilities should be provided with department-level data as well as data relevant to the team. Given that team members frequently rotate to other teams or to other hospitals, it is important to provide surveillance data to the relevant surgical team as close to the time of the procedure as possible.[53]

Even though it may take up to a year for the onset of infection symptoms, particularly for deep/organ space infections, feedback to surgical teams should never be delayed once the infection has been discovered. To mitigate against this delay, surveillance datasets can be developed as ‘live’ datasets and be updated and re-disseminated if new data from post-discharge surveillance becomes available. While the receipt of surveillance data is likely to have an immediate impact on performance, in line with the ‘Hawthorne effect’ (that is, performance is better when individuals know they are being observed) sustained practice change and SSI reduction will require targeted quality improvement activities.[15]

Results from SSI surveillance should also be reported regularly to the highest level of executive in the health service organisation. The executive should use SSI data as well as other data sources (e.g. admission data accreditation data) to:

- Identify trends in process and outcome measures
- Evaluate the impact of existing SSI reduction strategies
- Prioritise and design new initiatives to reduce SSIs
- Detect early warning signs of disease outbreak.

Providing SSI surveillance results to the executive also reinforces clinician accountability for surgical performance outcomes and recognises that infection prevention is a result of the combined actions of the health service and its individual clinicians.[54]

5.6.2 Public reporting and its benefits and risks

The public reporting of SSI surveillance data has several benefits. These include:

- Demonstration of quality improvement
- Promotion of public trust and clinician accountability
- Support for patient choice.[55]

Public reporting of SSI surveillance data can be used to engage and inform the community about surgery and infection outcomes. The community has certain expectations about the levels of acceptable risk associated with health care. While there is little evidence to indicate that public reporting has a direct effect on infection rates, SSI surveillance data that is inconsistent with community-held expectations of acceptable risk may reduce confidence in a healthcare organisation. In turn, this may drive health consumers to demand better surgical performance and outcomes, a greater investment in quality improvement and infection prevention and control strategies for surgical settings and, overall, a safer organisational culture.[36, 56-58]

There may be organisational risks associated with reporting of surveillance data publicly. These risks include:

- A focus on short-term goals
- Reluctance to experiment for fear of poor performance
- Prioritising of narrow objectives over inter-organisational goals
- A focus on an assessed area at the expense of a non-assessed one.[55]

It is critical to ensure that public reporting of performance does not lead to the under-reporting of SSI cases.[36] Health service organisation executives can mitigate this practice by effective monitoring of the data, identifying unexpected variation in data, and emphasising the usefulness of accurate surveillance data for motivating behaviour and practice change.[59] Another strategy for effective use of data to improve performance is to ensure that clinicians are provided the data as feedback, and promote benchmarking against like health service organisations.[60] To avoid unnecessary focus on short term goals and narrow objectives, a number of strategies might be considered in the early stages of developing and designing surveillance programs[60, 61], such as:

- Consulting surgical teams in the selection of surveillance measures to ensure that measures are relevant, and reflect clinical workflows and priorities
- Including suitable complementary measures, such as length of stay or number of referrals to the wound care clinic, to provide a broader picture of how SSIs may impact on wider health system performance
- Focusing on embedding long-term improvement, as well as immediate process changes.

Once a surveillance program has been developed and is underway, the surveillance team should maintain an awareness of advances in surgical technique and care and changes in models of care, care pathways and clinical guidelines.[60] Ensuring alignment of the surveillance program with these advances is crucial for ensuring continuing relevance of the surveillance program.

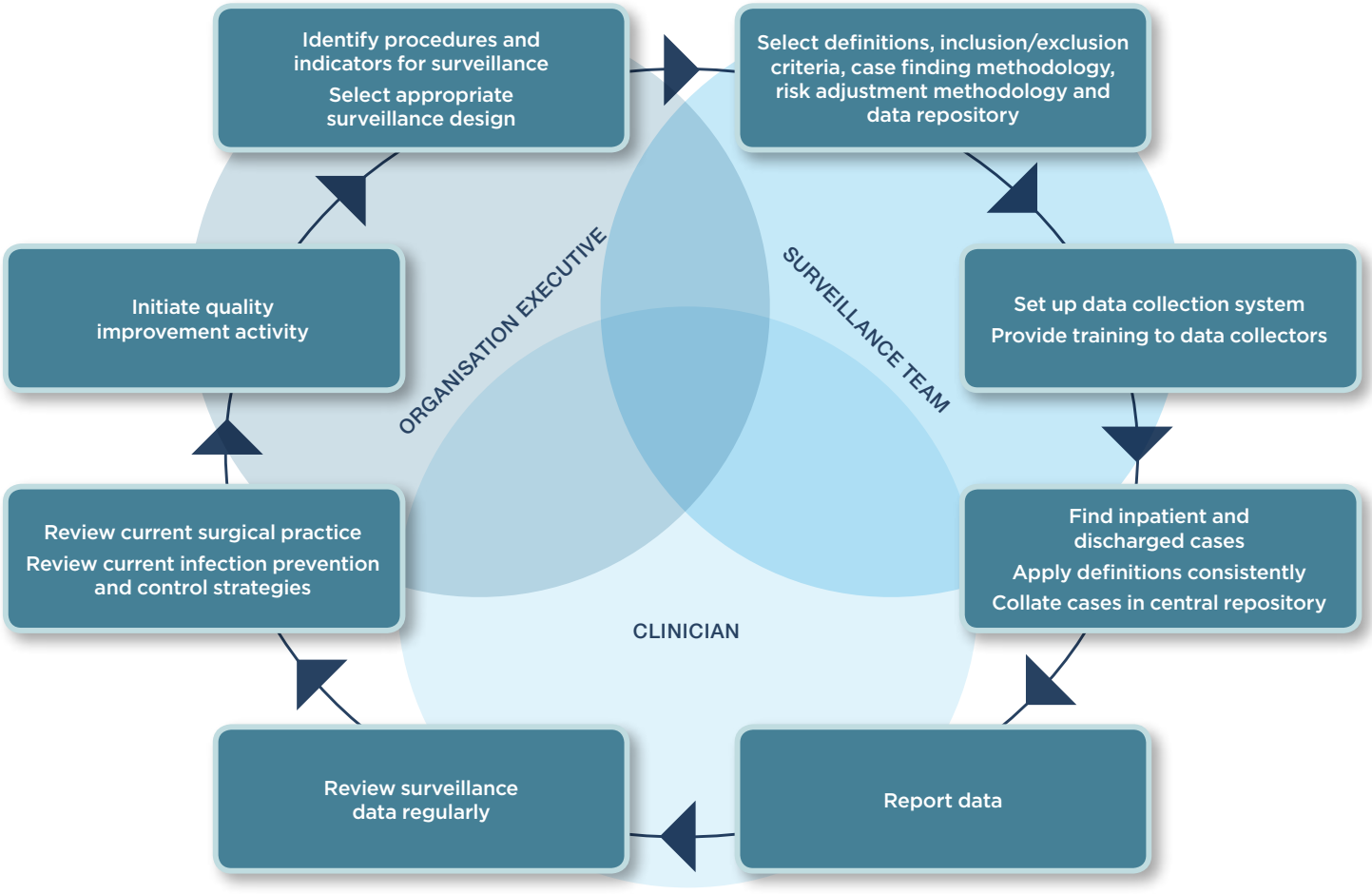
Publicly reported data may be misinterpreted by individuals who are not knowledgeable of the dataset or the specific clinical practice that is under surveillance.[58] In order to minimise any misinterpretation, SSI data should be reported clearly and be accompanied with clear language suitable for health consumers, and include all necessary qualifications and assumptions.

When developing the public reporting element of a SSI surveillance program the following factors should be considered:

- Is the data accurate and can valid comparisons be made?
- Has a standardised methodology been used to collect data?
- Is the data being reported accessible and useful to consumers and fair to the health service?
- Do meaningful explanations and interpretations accompany the surveillance data?[21]

5.7 A conceptual framework of an organisational surgical site infection surveillance program

Figure 2: An example of an organisational approach to surgical site surveillance



This figure has been adapted by the Australian Commission on Safety and Quality in Health Care from work previously developed by Healthcare Associated Infection Surveillance Western Australia

6. Risk adjustment

It is important to consider the impact of variation if a health service organisation wishes to benchmark their performance with others. Differences in procedure type, facility type and patient casemix can limit the comparability of surveillance data.

One way to enhance comparability is to perform risk adjustment on the dataset. Currently, SSI surveillance programs in New South Wales, South Australia, Victoria and Western Australia include risk adjustment; health service organisations in these states should refer to local protocols for specific requirements.

Risk stratification, which allows for the adjustment of the rate according to the risk of developing an SSI, can be used to adjust for casemix. A number of factors have been considered and have been included in a risk index used by the NHSN since 1991. A common risk stratification method is to stratify data by SSI type. In effect an SSI will be classified either as a 'deep', 'organ space' or 'superficial' wound infection. The rationale for this stratification is that the data for deep and organ space wound infections are likely to be more accurate because patients with these wounds are more likely to return to the health service organisation and seek further treatment. In contrast, patients who have a superficial wound infection are less likely to return to the hospital for further treatment and therefore the incidence of these infections is less accurately reflected in surveillance data.

Using the NHSN Modified Risk Index

When using the NHSN modified risk index, each operation is scored according to the presence or absence of the following risk factors:

1. a patient having an American Society of Anaesthesiologists (ASA) preoperative assessment score of 3, 4 or 5
2. an operation classified as either contaminated or dirty-infected
3. an operation with duration of surgery greater than a specified period of time.

Rates are then presented as stratified by risk index.

Two other factors commonly used together for risk stratification are the American Society of Anaesthesiologists physical status score (ASA-PS) and wound class. Further information on how these factors are used for risk stratification is described in the following sections.

6.1 American Society of Anaesthesiologists physical status (ASA-PS) score

The American Society of Anaesthesiologists physical status (ASA-PS) was created originally in the United States in 1978 for classifying a patient's physical status before surgery.[64] The score is now used globally to also predict perioperative infection risk. American Society of Anaesthesiologists scores are readily collected in surgical settings in Australian hospitals, as per clinical guidelines set by state and territory health departments and the Australian and New Zealand College of Anaesthetists, to screen patients for adverse reactions to sedation. Table 2 describes each American Society of Anaesthesiologists class in further detail. Class VI patients are normally excluded from SSI surveillance.

Table 2: American Society of Anaesthesiologists classification

ASA-PS score	Description
Class I	A normal healthy patient
Class II	A patient with mild systemic disease
Class III	A patient with severe systemic disease
Class IV	A patient with severe systemic disease that is a constant threat to life
Class V	A moribund patient who is not expected to survive without operation
Class VI	A declared brain-dead patient whose organs are being removed for donation

6.2 Wound class

Traditionally, wound class has been used to classify procedures. Wound class is determined by the degree of contamination of a surgical wound at the time of the operation. Table 3 describes the four wound classes.

This determination is made by a person involved in the surgical procedure (such as a surgeon or a surgical nurse).

Table 3: Wound classifications[65]

Wound Class	Description
Clean	An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow non-penetrating (blunt) trauma should be included in this category if they meet the criteria.
Clean-contaminated	Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.
Contaminated	Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g. open cardiac massage), or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered, including necrotic tissue without evidence of purulent drainage (e.g. dry gangrene) are included in this category.
Dirty/infected	Includes old traumatic wounds with retained devitalised tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing post-operative infection were present in the operative field before the operation.

6.3 Improving the validity of risk stratification

There is uncertainty about the validity of the NHSN Modified Risk Index to stratify patients at a higher risk of infection across all procedure types. Numerous studies have described a range of scenarios and procedures for which this index does not perform reliably. For example, data from Queensland examining five years of data and 13 surgical procedures showed the risk index was unable to discriminate risk for different procedures accurately, and lacked sensitivity.[66]

Data from the Victorian Healthcare Associated Infection Surveillance System also demonstrated the risk index correlated poorly with some procedures, such as coronary artery bypass graft surgery and that other patient factors should be incorporated.[67] Work in the United States by the American College of Surgeons has questioned the inclusion of wound classification, showing little difference in risk adjustment models that included or excluded this factor.[68] NHSN modified its approach to risk adjustment in 2011 by creating procedure-specific risk models for SSI, using multivariate modelling of variables within the NHSN dataset.[69] This relies on the identification and collection of additional patient-level and hospital-level data to determine risk factors relevant in different settings for different populations. However, there is still a lack of literature on which factors impact the occurrence of SSI, with causal relationships difficult to quantify.[70] In addition, changes to how and where surgery is performed, and how long patients stay in hospital post-operatively will continue to impact on the comparability of data.

The burden of data collection and the availability of data for modelling baseline rates should also be considered by health organisations when deciding whether to undertake more detailed risk stratification as part their SSI surveillance program.

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