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Reducing harm to patients from health care associated infection: the role of surveillance. Chapter 3: Surgical site infection – an abridged version

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Abstract

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Chapter 3: Surgical site infection

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Key points

- Surgical site infections (SSIs) are associated with substantial morbidity, mortality and costs.
- Surveillance of SSIs, coupled with prompt feedback of data from the infection prevention team to treating clinicians, can achieve major reductions in SSI rates.
- Reporting risk-adjusted, procedure-specific SSI rates is a measure of quality of surgical care.
- Surveillance methods based on the United States National Healthcare Safety Network (NHSN) have been widely used internationally. Australian state surveillance programs use the NHSN definitions.
- Australian states and territories differ in extent of SSI surveillance, resources available, and approaches to mandatory reporting and risk adjustment of infection rates.
- A national database of SSI rates would primarily be of value if it was timely and allowed valid comparisons of infection rates between hospitals. An agreed national approach to risk adjustment is required before this can occur. Ongoing local support is needed to promote data quality and ensure programs are responsive to local needs.
- Benefits of such a database would be:
  - a greater understanding of the nature and extent of SSIs after many types of surgery
  - efficiencies and economies in educational activities and support
  - development of improved surveillance methods.
- Validation studies are essential to develop confidence in data.
- There is no widely accepted method for post-discharge surveillance.
- Surveillance of surgical antibiotic prophylaxis and feedback of hospital performance has led to improvements in clinical practice.

Recommendations on surgical site infection

1. Local surveillance of SSI and infecting pathogens should be undertaken.
   - Surveillance should include all coronary artery bypass graft surgery, major joint prostheses, and other important surgeries (in terms of surgical frequency or SSI morbidity; for example, lower segment caesarean section) and procedures noted to have higher than expected SSI rates.
   - Standard NHSN surveillance methodology should be used.
   - Staff should be trained in data collection, audit and surveillance.

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- Post-discharge surveillance requires the development of a validated, cost-effective method.

2. Risk-adjustment methodologies for SSI surveillance to facilitate national benchmarking are required.
3. Surgical antibiotic prophylaxis should be used as a key national hospital quality-of-care measure.

3.1 Background

The development of infection in a surgical wound is probably the most widely recognised presentation of a healthcare-associated infection (HAI). Of all HAIs, surgical site infections (SSIs) have the greatest impact on length of hospital stay.[1,2]

3.2 Harm to patients

The effects of SSIs differ between surgical procedures. For example, in major joint prosthesis replacements, infection rates are low, but the consequences of infection are enormous. The patient often requires further surgery, removal and/or replacement of the prosthesis, and months of intravenous antibiotic therapy. For procedures such as caesarean sections, infection rates are higher, but the consequences usually less severe, with most patients not requiring readmission.

Reported SSI rates vary internationally depending on the procedure and the surveillance methodology used. A 1984 Australian national prevalence study found that 6.3% of 29 000 patients acquired an infection during their hospital stay.[3] In 1998, New South Wales Health funded the 2-year Hospital Infection Standardised Surveillance pilot study. The study revealed aggregated SSI rates of 1.7% for coronary artery bypass graft (CABG) of the chest and leg, 2.1% for CABG of the chest only, 7.1% for vascular surgery, 1.3% for hip prosthesis, 6.1% for knee prosthesis and 12.5% for colorectal surgery.

The Victorian Hospital-acquired Infection Surveillance (VICNISS) program has adapted the NHSN program definitions and has demonstrated higher SSI rates than the United States hospitals for CABG, hip and knee surgery.[4]

3.3 Impact on healthcare systems

SSIs are associated with significant morbidity, mortality and costs. A large study from the USA that quantified the impact of SSIs on mortality and healthcare costs found that patients who developed SSIs in the 1990s had median additional hospital stays of 6.5 days and excess direct costs of US$3089.[5]

The impact of SSIs varies considerably between procedures. SSIs after CABG surgery and major joint replacement have substantial consequences for patients and for healthcare costs. In a 2-year retrospective case-control study at the Alfred Hospital including 108 SSIs after CABG, patients with SSIs spent a mean of 2.89 days in an intensive care unit compared with 1.53 days for controls ($P = 0.035$). In general wards, patients with SSIs spent a mean of 10.8 days compared with 4.7 days for controls ($P = 0.0001$). The total excess cost related to increased length of stay and antibiotic treatment was A$12 419 per patient. For deep sternal infections, the mean excess cost was A$31 597 per patient.[6] In a multicentre study in Victorian public hospitals, the average cost of an SSI following hip arthroplasty was A$34 138, and knee arthroplasty was A$40 940.[7]

3.4 Surveillance methods

Many centres around the world have adopted standardised surveillance methods based on the NHSN system.[8–11] SSI surveillance methods, particularly the approach to risk adjustment, vary across Australian states and territories.[4]

3.4.1 Definitions of surgical site infections

All Australian state surveillance programs use essentially the same definitions for SSIs. The definition developed by the Australian Infection Control Association (AICA) National Advisory Board is the same as the widely used NHSN definition. However, the NHSN separates SSIs into superficial, deep and organ/space infection, whereas the AICA definition reports deep and organ space as a single category.

In a validation study of data submitted to the VICNISS Coordinating Centre following CABG, Friedman *et al*.[12] noted that infection control staff found it more difficult to identify superficial SSIs than deep ones. This is in agreement with the findings of Cardo *et al*.[13]

3.4.2 Detection of surgical site infections

Detection of SSIs in hospital is usually performed by infection control professionals (ICPs) trained in the use of surveillance definitions and methods. The ICP must ensure all procedures are included using accurate case-finding methods and record the corresponding denominator data. The ICP should seek out infections by screening a variety of data sources including charts, databases and interviews with medical staff.

Several studies have investigated the use of medical records as a more efficient means of detecting SSIs. These methods have generally proved unsatisfactory. Administrative databases contain limited clinical information, and data quality depends on accuracy of coding and is subject to variation between hospitals, compromising comparisons.[14–16]

Although post-discharge surveillance is likely to increase case detection of SSIs,[17,18] it is limited by the intensity of required resources. No method of post-discharge surveillance has found widespread acceptance. Post-discharge surveillance may be warranted for procedures that typically require a short hospital stay.[11]

3.4.3 Risk adjustment of infection rates

Hospitals should use surveillance data to compare their SSI rates with a benchmark, other hospitals, or with themselves over time.[19] Comparison requires the use of uniform definitions, accurate case finding, risk adjustment and a sample size that is sufficiently large.[20,21]

Risk stratification involves grouping patients with similar risks.[21,22] Numerous factors contribute to the risk of SSI and the influence of these factors must be considered. A risk index is used to adjust for the most important risk factors.

An effective risk index should:[23]

- comprise a small number of criteria that are easy to measure
- categorise patients into a small number of categories
- minimise variation in risk within a category, while maximising variation between categories.

The NHSN risk index has been widely used to stratify SSI rates.[24] Although it is generally thought to perform well for many operative procedures,[25] it discriminates poorly for procedures such as CABG[26,27] and caesarean sections.[28]

Attempts at identifying new risk indices have been made, usually using logistic regression, and some have been found to perform better than the NHSN risk index for certain procedures, however none have been widely adopted.

An alternative to a risk index is to use a standardised infection ratio (SIR) that can be used to compare rates over time against a benchmark or another hospital.[29] The SIR has been proposed as perhaps the easiest measurement for consumers and other stakeholders to interpret.[29] An SIR greater than 1 indicates more infections than expected and an SIR less than 1 indicates fewer infections than expected.

Some Australian hospitals monitor their SSI rates within their hospitals using control charts and cumulative sum reports.

3.4.5 Validation of surveillance data

Validation of surveillance data is essential for determining the reliability of data from multiple sources.[19]

There are surprisingly few studies validating surveillance data. Previous studies that compared SSI data collected by infection control staff to a 'gold standard' have come up with varied estimates of sensitivity and specificity, with sensitivity generally lower than specificity. For example, a recent German study reviewed data on bloodstream and lower respiratory tract infections, and estimated the sensitivity to be 66.0% and specificity to be 99.4%.[30]

An Australian study from the VICNISS Coordinating Centre reviewed data from SSI surveillance following CABG surgery.[12] For patients identified as having an SSI at any site, the estimated sensitivity was 55.0%, whereas specificity was 100%. For patients with a sternal wound infection only, the estimated sensitivity was 62.0% while the specificity was 100%.

3.5 Current surgical site infection surveillance

3.5.1 International surveillance

The NHSN definitions and methods have been widely used (sometimes with local modifications) in Germany, Belgium, France, Japan, UK, Thailand and several South American countries.[8–11] However, studies have demonstrated several factors with potential to affect comparability of surveillance data, including post-discharge surveillance, sample bias and design of validation studies.[31] It is generally accepted that comparisons are most reliable for deep SSIs during hospitalisation, rather than for superficial SSIs.

3.5.2 Australian surveillance

Almost all surveillance programs for SSIs in Australian hospitals are based on the definitions and methods of the NHSN, but reports and approach to risk adjustment vary between programs. Queensland and Victoria use the NHSN risk index, but New South Wales, the only state with mandatory surveillance, compares infection rates with those in similar hospitals by hospital 'peer group'.

Small hospital surveillance programs exist in New South Wales, Queensland, South Australia and Victoria. South Australia and Western Australia include private hospitals in their programs. While Victoria and Queensland have invested substantially in setting up independent coordinating bodies, surveillance programs in other states are run by state health departments.

The Australian Commission on Safety and Quality in Health Care sponsors the 'Safer Systems – Saving Lives' program in New South Wales, South Australia, Tasmania and Victoria, and the 'Delivering a Healthy WA' program in Western Australia. These programs follow the approach of bundling several infection control measures. This approach has been highly successful in North America. Australian programs use less rigorous measures of infection than previous SSI surveillance programs, and include standardised implementation and audit of evidence-based measures that reduce infection (e.g. appropriate antibiotic prophylaxis and hair removal).

Victoria and New South Wales are the only states that currently report SSI data publicly. VICNISS reports aggregated data using the NHSN risk index,[32] whereas New South Wales stratifies data using the peer grouping of hospitals assigned by the Australian Council on Healthcare Standards.[33]

3.5.3 Registries of major surgical procedures

Registry databases exist for two of the most important surgical procedures performed in Australia: cardiac surgery and major joint prosthesis placement.

The Australasian Society of Cardiac and Thoracic Surgeons (ASCTS) and the Victorian Department of Human Services have together developed a program to collect data on cardiac surgery in Victorian hospitals. The project began in 2001. Public reports of performance indicators, including 30-day mortality following isolated CABG and rate of deep sternal wound infections, are published annually and are freely available to the public.

The ASCTS registry is expanding to include all public hospitals in New South Wales and six additional surgical units from South Australia, Queensland and the Australian Capital Territory. The aim is to engage all units in Australia in the registry by 2010.

The Australian Orthopaedic Association established a National Joint Replacement Registry, which began data collection in 1999 to collect a defined minimum dataset including patient characteristics, prosthesis type and features, method of prosthesis fixation and surgical technique used. The principal measure of outcome is revision surgery, but mortality is also monitored. The Australian Government Department of Health and Aging continues to fund the registry.

Benefits of, and issues with, registries

The registries discussed above collect detailed information on patients undergoing major surgical procedures, however, they do not use AICA National Advisory Board or NHSN definitions for SSI.

A study by the VICNISS Coordinating Centre and ASCTS illustrated potential advantages and difficulties of collaboration between state hospital infection control groups and registry groups.[12] These included:

- the need to ensure that all relevant surgical procedures were captured by both databases
- the benefits of multicentre research, including improvements in risk adjustment using data already collected in the registries
- limitations to ongoing collaboration between the organisations due to requirements for ethics committee approvals from multiple hospitals for data exchange.

3.5.4 Benefits of surgical site infection surveillance

SSI surveillance has demonstrated benefits. For example, the Study on the Efficacy of Nosocomial Infection Control (SENIC) study, carried out in the 1980s, showed that infection control programs that were effective in reducing SSIs included the following components:[1]

- organised surveillance, with feedback of data to staff involved in patient care (e.g. surgeons)
- activities to ensure that appropriate preventive practices were carried out
- an adequate number of trained ICPs to perform surveillance and supervise the infection control program
- involvement of a physician or microbiologist with skills in infection control.

Programs with these components reduced rates of surgical wound infections by 35%. These findings provided evidence justifying the development of expanded hospital infection programs in the USA, and subsequently in other developed countries.

In Germany, voluntary participation in active SSI surveillance between January 1997 and June 2004 was associated with a sustained and significant reduction in the incidence of infection.[34,35]

A similar reduction in incidence was seen following commencement of surveillance in France. In a large SSI surveillance network in south-east France from 1995 to 2003, SSI rates were reduced by 45% over a period of 9 years. This was interpreted as a 5% decrease in the SSI rate per year. This decrease was constant over the study period and was observed for almost all types of surgical operations (e.g. orthopaedic, gastrointestinal, urology). In another French network of volunteer surgical wards,[36,37] the crude SSI incidence decreased from 3.8 to 1.7 over 6 years, and the NHSN-adjusted SSI incidence decreased from 2.0 to 1.0%.

A Tasmanian study demonstrated not only that a surveillance program resulted in a reduction in SSIs over 12 years, but that interrupting the program for 15 months halted the reduction.[38]

3.5.5 Surgical antibiotic prophylaxis

Administration of antibiotics is recommended before some surgery to reduce the incidence of SSIs, and is a category 1A recommendation from the Centers for Disease Control and Prevention.[39]

Process indicators including surgical antibiotic prophylaxis are extremely useful for measuring hospital performance, particularly as there is no need for risk adjustment and all hospitals, should be able to achieve high levels of compliance.

In Victoria, the VICNISS Coordinating Centre collects data on choice of antibiotic, timing of the first dose and duration of administration for surgical antibiotic prophylaxis. Data are judged either 'concordant' or 'not concordant' based on the Australian national guidelines.[40]

Reports on compliance are distributed to hospitals. Hospitals appear to have found this useful and the reports have generated considerable interest and some improvements.[4]

No other states or territories in Australia routinely collect and report on data on surgical antibiotic prophylaxis.

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