A new surgical site infection improvement programme for New Zealand: early progress

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ABSTRACT

Two to five percent of those who have an inpatient surgical procedure will experience a surgical site infection (SSI). The Health Quality & Safety Commission has instituted New Zealand’s first national Surgical Site Infection Improvement Programme (the SSII Programme), delivered jointly by Auckland and Canterbury District Health Boards. Through a combined package of surveillance and improvement interventions the SSII Programme aims to reduce the incidence of SSIs in New Zealand hospitals, beginning initially with hip and knee arthroplasties. Within one year of the programme starting there has been a significant nationwide improvement in the timing of surgical antimicrobial prophylaxis (p<0.0001), and the administration of the correct dose (p<0.0001). National compliance with an alcohol-based skin preparation remains high at >95%. In this paper we describe the purpose, background, structure and rationale of the programme and provide results to date.

Two to five per cent of those who have an inpatient surgical procedure of any kind will experience an infection at the surgical site. Surgical site infections (SSIs) are the second most commonly reported healthcare associated infection, comprising 17 to 22% of healthcare associated infections in high and middle income countries. A patient with an SSI typically costs hospitals twice as much as a patient without an infection. SSIs can rapidly progress and treatment may be lengthy, expensive and difficult, especially in the case of infected joint arthroplasties, where management often involves extensive debridement, long courses of antibiotics, implant revision and rehabilitation.

In the US in the mid-1970s, the US Centers for Disease Control (CDC) Study on the Efficacy of Nosocomial Infection Control project (SENIC) established that, provided certain key components were in place, infection surveillance and control projects instituted in American hospitals in the 1960s reduced nosocomial infections, including SSIs, by 32%. Since then, reductions have been achieved globally by similar surveillance programmes (see below).

New Zealand’s Surgical Site Infection Improvement Programme, known as the SSII Programme, was instituted by the Health Quality & Safety Commission (the Commission) in 2012, with an initial focus on hip and knee arthroplasties. The SSII Programme is delivered jointly by Auckland and Canterbury District Health Boards (DHBs) and funded by the Commission.

The SSII Programme’s basic premise is that the incidence of SSI in New Zealand can be reduced by a quality improvement package consisting of national, co-ordinated, long-term surveillance of SSIs using a comprehensive programme of data collection and sharing, accompanied by institution and tracking of adherence to internationally recognised best clinical practices known to prevent SSIs.

In this paper we discuss the background, structure, aims and rationale of this new programme and provide a summary of results to date.
Surgical site infection in New Zealand

The SSII Programme commenced with hip and knee arthroplasties because of their high volume, relatively consistent surgical procedure, and the high cost and serious harm to patients when an SSI occurs.

The numbers

Hip and knee arthroplasties are two of the most commonly performed operations in the US. In 2012, more than 670,000 knee and 450,000 total or partial hip arthroplasties were performed in US hospitals, and these numbers are increasing.8,9 The CDC’s National Healthcare Safety Network (NHSN) reports SSI rates in hip arthroplasties of 0.67% to 2.4% in the period 2006-08, and in knee arthroplasties from 0.68% to 1.60%.10 It is estimated that annually between 6,000 and 20,000 patients in the US have an infected hip or knee arthroplasty.11

In New Zealand these two procedures are also common, with the number of hips replaced per capita comparable with that of the US. The New Zealand National Joint Registry (NJR) has tracked hip and knee arthroplasties in public and private hospitals since 1999. In 2012, 7,481 primary hip arthroplasties and 6,346 primary knee arthroplasties were registered.12 These procedures are provided in every DHB and the numbers are increasing: from 2011 to 2012 the number of NJR-registered hip replacements increased 3.6%, knee replacements increased by 1.5%, and unicompartmental knee replacements (replacement of either the medial or lateral knee compartments) increased by 18%. The year-on-year rate of increase of registered joints from 2011 to 2012 has doubled to 2.7%.12

Data reported by the SSII Programme show that of the 10,596 publicly funded hip and knee procedures from March 2013 to June 2014, 134 patients’ surgical sites became infected, an incidence of 1.3% (95% confidence interval 1.1–1.5). The infection was recognised either during the initial admission or resulted in readmission within 30 days for a superficial infection or 90 days for a deep infection.13

The costs

Infection following hip and knee replacement is a serious complication. Treating these patients may cost three to four times as much as the original surgery,14 the length of the patient’s hospital stay (LOS) may be greatly increased,15–17 poorer long-term functional outcomes result, and mortality is increased.14,18 Treatment is usually complex, often requiring removal of the infected prosthesis, radical debridement of necrotic and infected tissue, insertion of a spacer implant, prolonged antibiotic treatment, and a return to surgery for a repeat arthroplasty more than six weeks later. Each additional procedure carries the potential for further complications, pain, impaired mobility and a long period of recuperation.

Recent studies from the US, England and Australia have highlighted the excess cost and length of stay associated with surgical site infections following hip and knee arthroplasties.19–21 An Australian study reported an average 27 day increase in the LOS attributable to hip and knee replacement infections, at a cost of AUS$4.6m for 126 infections—the total cost of the infections for the state of Victoria for a year was just over AUS$5m.21

Here in New Zealand published data are lacking, but recent work done at Auckland DHB found that when patients identified with an SSI after a primary procedure (n=11) were matched on a 1:2 ratio with patients who did not get an infection, the mean excess cost of SSI was NZD$40,121 and excess LOS was 42 days (pers. comm. Gow N, Auckland DHB, 2 Feb 2015).

Northland DHB reported an average cost of $78,000 for an infected hip replacement. The cost for one single infected hip replacement in 2013, which involved four readmissions over five months, was $112,000 (pers. comm. Cunningham C, Clinical Nurse Specialist, Infection Prevention & Control, Northland DHB, 4 Aug 2014).

In short, “Deep infection following an arthroplasty is a disaster for the patient and expensive to manage”.22
The New Zealand Surgical Site Infection Improvement (SSII) Programme

Reducing SSIs in New Zealand—background

New Zealand’s first dedicated national health quality improvement body, the Quality Improvement Committee (QIC), a ministerial committee supported by the Ministry of Health, was founded in 2007 under Section 9 of the New Zealand Public Health and Disability Act 2000. QIC was funded for a specific suite of national quality improvement programmes known as NQIPs. One of these programmes was infection prevention and control, including catheter-related bloodstream infection prevention, the hand hygiene programme, and recommendations for a surgical site infection surveillance programme. In 2010, QIC’s successor, a crown agency, the Health Quality & Safety Commission, decided, after consultation with the sector, that it was vital to continue this important work. The Commission obtained an independent cost-benefit analysis that found surveillance was likely to lead to significant reductions in SSI rates and a strongly positive economic benefit overall. An automated system was estimated to cost a similar amount as a manual system but would provide ongoing cost savings and the potential for expansion. On the strength of this, the SSII Programme was developed.

How do we get better? Structuring the job of improving

The Commission formed a steering group with senior clinical leadership and jointly led by Auckland and Canterbury DHBs. The Programme settled on a multifaceted improvement approach consisting of:

1. A nationwide surveillance system and data warehouse called “National Monitor” hosted by Canterbury DHB, initially targeting hip and knee arthroplasties, and to be expanded in 2015 to include selected cardiac surgery procedures;
2. Promoting evidence-based practices proven to reduce SSI incidence, and encouraging clinicians to use them consistently, and
3. Measuring the implementation of these best practices, and reporting on adherence and results (see the SSI quality and safety marker, or QSM, below).

1. SSII: surveillance—how it works and who uses it

SSI surveillance involves the collection and provision of reliable data allowing clinicians to make meaningful comparisons between local incidence rates and national benchmarks and monitor changes in local rates over time. There is strong international evidence that the monitoring and reporting of SSIs leads to a mean reduction in their incidence, on the order of 8% per year (+/- 4%). The Dutch surveillance network PREZIES (PREventie van ZIEkenehsuisfecties door Surveillance) reported a 31% reduction in infection rates four years following inception, which increased to 57% after five years. The German Krankenhaus Infektions Surveillance System (KISS) was associated with a 25% reduction in SSI incidence in three years, and the Northern France INCISO system contributed to a relative reduction of 50% in SSI incidence in over 150,440 surgical patients over six years (3.8% to 1.7%). Another French system, the eight-year national ISO-RAISIN system (Infection du Site Opératoire—Réseau Alerte Investigation Surveillance des Infections) was associated with a 36% reduction in hip SSI over 7 years. Similar results have been found in Brazil (a reduction in overall incidence from 8.8% to 3.3% in nine years).

In 2008 Krukowski and Bruce concluded in the BMJ, “it has been clear for almost three decades that the routine collection and dissemination of rates of surgical site infection results indirectly in a worthwhile reduction.”

International surveillance of surgical site infection

The basic model of large-scale SSI surveillance and improvement is:

- **Local**—infection data are collected, reported, and clinicians seeing their data are encouraged to seek ways to improve their practice and reduce the incidence of SSI.
- **National**—infection data are collected
and reported nationally. Hospitals and DHBs regularly review the data and encourage the adoption of effective national initiatives to secure a reduction in the incidence of SSI.

In the US the CDC has led the way in nosocomial infection surveillance. It has tracked HAIs via the National Nosocomial Infection Surveillance System (NNIS) since 1970. Updated to a web-based protocol in 2005, and now known as the National Healthcare Safety Network (NHSN), this surveillance system uses well-validated, internationally adopted definitions and data protocols designed to minimise the burden of collection and reporting.39,40

There are now SSI surveillance and improvement programmes active in England, Scotland, Wales, Northern Ireland, The Netherlands, Belgium, France, Japan, Denmark, and Germany.37,41-49 The European Centre for Disease Prevention and Control’s (ECDC) European Surveillance System (TESSy) surveils SSIs with the HAI-Net SSI protocol from, in 2011, 20 surveillance networks in 16 reporting European countries.50 Australia has surveillance programmes in several states including New South Wales, Victoria (the VICNISS programme),51 and Western Australia, though a 2008 national report concluded, “Standardised and strategic approaches to surveillance . . . is [sic] seriously lacking in most states and territories.”52

New Zealand SSI surveillance

Until recently, surveillance in most New Zealand hospitals was only carried out locally, without common methods of data collection, and with little sharing of the results. Southern Cross Hospitals have used a surveillance system covering 13 hospitals since 2004, but without public reporting. This was the only significant multi-site SSI monitoring programme in the country until the institution of the SSII Programme under the Commission in 2013.

National Monitor

The SSII Programme, New Zealand’s first national SSI improvement programme, utilises National Monitor from ICMet, software previously used with success for English, US, Australian and Scottish SSI surveillance programmes. This was trialled with eight DHBs in a development phase in early 2013. National Monitor was rolled out to the remaining DHBs in July 2013. Complete data collection methodology is available at the Commission website.13

2. SSII: Improvement—what we can do to prevent SSIs

Surveillance drives improvement, particularly alongside the adoption of standardised application of practices proven to reduce the incidence of SSIs. As always it is actions that result in improvement—measurement serves simply to inform and prompt the needed actions. Throughout New Zealand there has been inconsistent implementation of clinical practices associated with a reduction in SSI—eliminating unjustified variation in practice is a key element of quality improvement.53,54

The package of interventions

1. The right antibiotic in the right dose—since the introduction of the WHO Surgical Safety Checklist in 2008 there has been a requirement that during the Time Out phase, before the incision is made, the question is asked, “Has antibiotic prophylaxis been given within the last 60 minutes?” There is strong evidence to recommend cefazolin 2g I/V for routine antibiotic prophylaxis for hip and knee replacements.55 Prophylaxis should be administered as a single dose within 60 minutes before knife to skin.52 Data and clinical practice guidelines do not support continuing antimicrobial prophylaxis more than 24 hours after surgery.56 The post-operative administration of three doses of cefazolin (2g) eight-hourly is accepted, but antibiotics should be discontinued within 24 hours after surgery.55

2. Skin antisepsis—appropriate skin antisepsis before incision should always be based upon a preparation including at least 70% alcohol (eg, chlorhexidine gluconate/alcohol or povidone-iodine/alcohol solution).57

3. Clipping of hair overlying surgical wound sites (avoiding shaving, which increases epidermal micro-trauma and subsequent bacterial colonisation).58
3. Measurement—how do we know we’re doing the right thing? Process and outcome measures of the SSII Programme QSM

The Commission has instituted a set of quality and safety markers (QSMs) to monitor adherence to best practice.\textsuperscript{59} There is now a suite of five QSMs comprising 23 individual measures in place tracking the work and results of quality improvement in New Zealand.

The SSII Programme QSM is derived from the intervention guidelines and draws directly on data saved in National Monitor.

**Process markers**
1. Right antibiotic in the right dose—is cefazolin ≥2g being used? To allow for instances of beta-lactam allergy, the threshold for compliance is set at 95%.
2. Correct timing for antibiotic prophylaxis—is the antibiotic given within 60 minutes before knife to skin? This should happen in all primary procedures, so the target is 100%.
3. Appropriate skin antisepsis—has a 70% alcohol/chlorhexidine or 70% alcohol/povidone-iodine solution been used? This also should occur on all occasions, so the target is 100%.

**Outcome**
Rate of SSIs per 100 procedures for total hip and total knee arthroplasties, where the SSIs is defined as superficial, deep incisional or joint space, occurring in hospital (in hospital refers to an infection occurring during the initial admission or requiring readmission within 30 days (superficial) or within 90 days (deep and organ space) post operation).

Results by DHB are published publicly.

**Timing:** This has improved from one DHB with 100% compliance in July-September 2013 to five DHBs in January-March 2014. Fourteen DHBs reported prophylaxis on time for more than 95% of primary procedures. The biggest factor resulting in non-compliance was the number of DHBs that had cases where timing wasn’t recorded. For April to June 2014, 12 DHBs had more than one procedure where timing wasn’t recorded; five of these had more than 10 such procedures. Only 2% of cases had antibiotic prophylaxis recorded as either early or late.

**Choice and dose of antibiotic prophylaxis:** There has been a significant increase in compliance with this measure each surveillance period. Ten DHBs now comply with this QSM with five more being at least 90% compliant. Most non-compliant DHBs reported the use of a 1g dose of cefazolin (5% in this quarter down from 13% in the first period 2014). One DHB continues to use cefuroxime for antibiotic prophylaxis. This accounts for approximately 5% of the non-compliance.

**Alcohol-based skin preparation:** Thirteen DHBs have reached 100% compliance (11 for the first time in the last quarter) and 18 DHBs are greater than 90% compliant. Only 1% of procedures receive aqueous povidone–iodine. Another 2% have ‘Other’ recorded as the skin preparation.

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<tr>
<th></th>
<th>July–Sept 2013 (a)</th>
<th>Oct–Dec 2013 (b)</th>
<th>Jan–March 2014 (c)</th>
<th>April–June 2014 (d)</th>
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<td><strong>On time (100% target)</strong></td>
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<tr>
<td>Primary procedures</td>
<td>89% (1475/1660)</td>
<td>90% (1859/2078)</td>
<td>92% (1974/2148)</td>
<td>94%** (2373/2528)</td>
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<td><strong>Dose and choice of antibiotic (95% target)</strong></td>
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<td>≥2g cefazolin</td>
<td>55% (1042/1887)</td>
<td>68% (1579/2323)</td>
<td>78% (1832/2350)</td>
<td>85%** (2322/2738)</td>
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<td><strong>Alcohol-based skin preparation (100% target)</strong></td>
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<td></td>
<td>97% (1827/1887)</td>
<td>96% (2234/2323)</td>
<td>98% (2295/2350)</td>
<td>97% (2664/2738)</td>
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<td><strong>Surgical site infection rate (%)</strong></td>
<td>1.6% (30/1887)</td>
<td>1.3% (30/2323)</td>
<td>1.0% (24/2350)</td>
<td>1.2% (34/2738)</td>
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**Table 1.** Quality and safety marker (QSM) process measures and surgical site infection rate July 2013 to June 2014

\* change (a) to (d) significant at p<0.0001
**Surgical site infections:** of the 9,298 publicly funded hip and knee procedures from July 2013 to June 2014, 118 patients’ surgical sites became infected. The infection occurred either during the initial admission or required readmission within 30 days for a superficial infection or 90 days for a deep infection. This is an incidence of 1.3% (95% confidence interval 1.1–1.5); 77 (0.75%) were deep or organ/space (ie involving deep tissues or the joint space) and 57 (0.55%) were superficial (involving skin and subcutaneous tissue).

**The future of SSI prevention**

The SSII Programme has only recently commenced, but the initial findings are encouraging and the international evidence suggests the programme will reduce the rate of SSIs given sufficient time. After extensive consultation with cardiac specialists, SSI surveillance and best practice interventions are in the process of extension to selected cardiac surgery procedures, including coronary artery bypass grafts.

The Armenian physician and ‘father of quality assurance’ Avedis Donabedian (known by his students as ‘Mr. Structure-Process-Outcome’) defined the paradigm of health care systems and delivery from which QSMs take their shape. “Things won’t improve,” wrote Donabedian, “until something is done about the design of the system.” Donabedian defined technical excellence as ‘doing the right thing’ (appropriate care based on the best available evidence) and ‘doing it right’ (delivering safe, timely care).

A reduction in the rates of SSIs in our hospitals can be achieved through adherence to best practice. The system is now changing and greater consistency is being achieved in key processes. The Commission is grateful for the contribution made by all DHBs and acknowledges the substantial commitment of many individuals, particularly the many clinicians, who have engaged with this national initiative to improve patient safety in New Zealand.

**Competing interests:**

Arthur J Morris received personal fees from Health Quality & Safety Commission, during the conduct of the study. Alan Merry is Chair of the Health Quality and Safety Commission. Carl Shuker is the principal advisor, publications, for the Health Quality & Safety Commission.

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