Reducing Harm | Improving Healthcare | Protecting Canadians

PREVENT SURGICAL SITE INFECTIONS

Getting Started Kit

December 2014

www.saferhealthcarenow.ca

safer healthcare now!

Safer Healthcare Now!

We invite you to join *Safer Healthcare Now!* to help improve the safety of the Canadian healthcare system. *Safer Healthcare Now!* is the flagship program of the Canadian Patient Safety Institute and a national program supporting Canadian healthcare organizations to improve safety through the use of quality improvement methods and the integration of evidence in practice.

To learn more about this intervention, to find out how to join *Safer Healthcare Now!* and to gain access to additional resources, contacts, and tools, visit our website at www.saferhealthcarenow.ca

This Getting Started Kit (GSK) has been written to help engage your interprofessional/ interdisciplinary teams in a dynamic approach for improving quality and safety while providing a basis for getting started. The Getting Started Kit represents the most current evidence, knowledge and practice, as of the date of publication and includes what has been learned since the first kits were released in 2005. We remain open to working consultatively on updating the content, as more evidence emerges, as together we make healthcare safer in Canada.

Note:

The Getting Started Kits for all interventions are available in both French and English.

Acknowledgements

Safer Healthcare Now! and the authors of this document would like to acknowledge and thank:

Financial support to update this kit was provided in part by 3M Canada

The Canadian Patient Safety Institute (CPSI) is acknowledged for their financial and in-kind support of the *Safer Healthcare Now!* Getting Started Kits

Prevent Surgical Site Infections Getting Started Kit Contributors

We also wish to thank and acknowledge our Canadian Faculty who have contributed significantly to the work of the Surgical Site Infection (SSI) teams and the revisions to this Getting Started Kit.

Dr. Kourosh Afshar
Associate Chief of Surgery, Quality and Safety, BC Children's Hospital

Julie Bedford
Surgical Clinical Reviewer, BC Children's Hospital

Paule Bernier
Clinical Nutritionist, Critical Care Team, Jewish General Hospital, Montréal
Présidente, Ordre professionnel des diététistes du Québec

Tamara Chan
Surgical Clinical Reviewer, BC Children's Hospital

Louis-François Côté
Clinical Nutritionist, Surgery Team, Jewish General Hospital, Montréal

Virginia Flintoft
Project Manager, University of Toronto
Measurement Lead, *Safer Healthcare Now!*

Susan Fryters
Antimicrobial Utilization/Infectious Diseases Pharmacist
Alberta Health Services, AB

Nadine Glenn
Patient Safety Improvement Lead, Canadian Patient Safety Institute

Dr. Claude Laflamme
Physician Lead for the *Safer Healthcare Now!* Surgical Site Infection Intervention
Director of Cardiac Anesthesia, Sunnybrook Health Science Centre, Toronto, ON
Assistant Professor, University of Toronto

Anne MacLaurin
Patient Safety Improvement Lead, Canadian Patient Safety Institute

Dr. Nicole Mitmann
Executive Director, Health Outcomes and PharmacoEconomic (HOPE) Research Centre, Sunnybrook Health Sciences Centre

Dr. Giuseppe Papia
Physician Lead of Cardiovascular Intensive Care Unit, Department of Surgery
Division of Cardiac and Vascular Surgery & Department of Critical Care Medicine
Sunnybrook Health Sciences Centre

Dr. Peter Riben
Consultant in Community Medicine, BC

Jennifer Rodgers
Patient Safety Improvement Lead, Canadian Patient Safety Institute

Syed Sarwar
Project Lead, *Safer Healthcare Now!* Surgical Site Infection Intervention
Project Coordinator, Quality & Patient Safety, Sunnybrook Health Sciences Centre

Nikki Smith
Project Coordinator, Canadian Patient Safety Institute

Dr. Tim Tang
Anaesthetist, Foothills Medical Centre, Alberta Health Services, Calgary Region, AB

Glenda Tapp
Perioperative Nurse Educator, Newfoundland and Labrador

Daniel Thirion
Pharmacist, McGill University Health Centre
Professeur agrégé de Clinique, Faculté de Pharmacie
Université de Montréal, Montréal, QC

Marlies van Dijk
Director of Clinical Improvement, BC Patient Safety & Quality Council

Diane White
Manager of Infection Prevention and Control, North York General Hospital, Toronto, ON

Table of Contents

Disclosure

Dr. Claude Laflamme is a member of 3M Global Advisory Board on Perioperative Thermoregulation.

Executive Summary

Surgical site infections (SSI) result from colonization with a bacterial load greater than the capability of the immune system to manage. SSI can significantly increase costs, morbidity and mortality among surgical patients.

Canadian healthcare continues to struggle with surgical site infections. Despite advances in aseptic technique, antibiotic prophylaxis, and less invasive surgical techniques, healthcare associated infections (HAI) continue to complicate the recovery of many surgical patients.

"The Getting Started Kit for the Prevention of Surgical Site Infection, 2014" represents the new and updated *Safer Healthcare Now!* recommendations for SSI prevention in healthcare. The recommendations contained in this Getting Started Kit are designed to assist healthcare facilities in prioritizing and implementing surgical site infection prevention efforts.

These recommendations are primarily based on HAI prevention guidelines published by numerous health organizations, including the American Society of Health System Pharmacists (ASHP), Infectious Diseases Society of America (IDSA), Surgical Infection Society (SIS), European Centre for Disease Prevention and Control (ECDC), National Institute for Health and Care Excellence (NICE), Society for Healthcare Epidemiology of America (SHEA), Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), Early Recovery After Surgery (ERAS) and relevant literature research. These recommendations also represent the consensus of the experts in Canada that structure the Canadian Patient Safety Institute SSI Faculty. This guideline describes SSI issues in all three stages of surgery: Pre-op, Intra-op and Post-op.

Note: This guideline provides recommendations for conventional surgical procedures. They may not be effective in rare surgical conditions. Also, it does not provide any information for burn and transplant patients.

Firstly, this kit provides updated information on four major prevention strategies to reduce surgical site infections in adults:

Prophylactic Antimicrobial coverage

a. *Appropriate use of prophylactic antibiotics*

- Prophylactic antibiotic infusion to be started and completed within 60 minutes for most antibiotics, or within 120 minutes for vancomycin and fluoroquinolones prior to skin incision or application of tourniquet.
- Prophylactic antibiotic administration should be started and completed within 60 minutes prior to first incision for c-sections instead of after cord clamping.

- Antibiotics administered for cardiac, thoracic, orthopaedic and vascular patients should be discontinued within 24 hours of the end of surgery, whereas non-complex and uncomplicated surgeries require no further administration of antibiotics following surgery.
- Antibiotic prophylaxis should only be repeated for surgeries lasting longer than two half-lives of the antibiotic (e.g. four hours for cefazolin).

b. *Antiseptic use*

- It is recommended patients should shower or bathe with either soap or an antiseptic agent on at least the night before the operative day.
- Intra-operative skin preparation should be performed with an alcohol-based antiseptic agent, unless contraindicated.
- To maximize its efficacy, two per cent CHG/70 per cent alcohol skin antiseptic that will be covered by the surgical dressing should not be washed off at the end of surgery.
- In order to reduce the risk of fire, it is imperative that CHG-alcohol skin antiseptic be allowed to air dry for at least three minutes or longer if there is excessive hair at the surgical site.

c. *Decolonization*

- Mupirocin nasal ointment has the ability to nearly eradicate *S. aureus* from the nasal site.
- Photodynamic Therapy (PDT) along with chlorhexidine gluconate wipes have also been shown to reduce the rate of SSIs

d. *Antiseptic Coated Suture*

- Sutures coated with antiseptic agents have been recommended to reduce the rate of SSIs. However, "do not routinely use antiseptic-impregnated sutures as a strategy to prevent SSIs."

Appropriate hair removal

- No hair removal prior to surgery is optimal.
- If hair removal is necessary, clippers should be used outside of the OR within two hours of surgery. No hair removal to be done prior to admission.

Maintenance of perioperative glucose control

- Perioperative blood glucose levels should be checked on all surgical patients who are diabetic or have risk factors for diabetes.
- Strict blood glucose levels (<6.1 mmol/L) should be avoided. Blood glucose should be maintained below 10-11 mmol/L during the perioperative period.
- Random pre-op blood glucose values should be <10 mmol/L.

Perioperative normothermia

- Measures should be taken to ensure that the core temperature of surgical patients remains between 36.0^{0}C and 38.0^{0}C pre-operatively, intra-operatively, and postoperatively.
- Pre-warming and intra-operative warming are indicated for all surgeries scheduled to last 30 minutes or more.
- Fluid warmers should be used if the surgical procedures is planned to last more than one hour.
- The ambient room temperature in the OR should range between 20^{0}C to 23^{0}C.

Secondly, there are additional evidence-based topics within this guideline that were not discussed in the previous Getting Started Kit:

- SSI Health Economics
- Canadian Pediatric SSI Journey – B.C. Children's Hospital
- Enhanced Recovery After Surgery (ERAS)
- National Surgical Quality Improvement Program (NSQIP)
- SSI Individual Risk Factors
- SSI Impact on Patient's Perspective and Quality of Life
- OR Environment and SSI
- SSI Prevention Compliance

The goal of the Canadian Patient Safety Institute SSI Faculty was to develop a tool that provides evidence-based recommendations when available or otherwise best evidence available at the time of publication. When the literature did not provide enough evidence, the opinions of Canadian experts were used.

A thorough systematic review was conducted to include all of the current evidence-based strategies around the world from 2005 to 2013. The literature search was carried out in PubMed, Embase, MEDLINE and Cochrane Library of Randomized Controlled Trials. These new recommendations along with the previous strategies now provide information on almost every facet of surgical site infection prevention. However due to space constraints, this bundle is not inclusive of all SSI prevention strategies.

Abbreviations for the acronyms

ASHP	American Society of Health System Pharmacists
CDC	Centers for Disease Control and Prevention
CMTF	Canadian Malnutrition Task Force
ECDC	European Centre for Disease Prevention and Control
ERAS	Early Recovery After Surgery
IDSA	Infectious Diseases Society of America
IHI	Institute for Healthcare Improvement
NHSN	National Healthcare Safety Network
NICE	National Institute for Health and Care Excellence
SCIP	Surgical Care Improvement Project
SHEA	Society for Healthcare Epidemiology of America
SIS	Surgical Infection Society
WHO	World Health Organization

Introduction

Safer Healthcare Now! first introduced the SSI Getting Started Kit in 2005 and since then, data has been captured on SSI prevention processes (four major components) that has been self-reported by 145 organizations throughout Canada. However, only 43 per cent (63/145) of the organizations reported data from September 2012 until August 2013. Although not reported, we recognize that data are still captured in some organizations and reported locally and/or provincially.

The main goal of the *Safer Healthcare Now!* measurement team is to increase enrollment and have organizations report their SSI data, in order to capture the effectiveness of *Safer Healthcare Now!* across Canada within the next five years (2014-2018). The annual goal for the team is to increase overall annual enrolment and reporting of data by 10 per cent every year. However, the *Safer Healthcare Now!* team understands that provinces that have local data collection tools will not value duplicate processes.

According to the data captured, *Safer Healthcare Now!* has contributed to the improvement of surgical care safety. There has been a 60 per cent decrease in the surgical site infections rate in clean and clean-contaminated surgeries from 2005 to 2010 (**Figure 1**). The four process indicators over time included:

- Per cent of Patients with Timely Prophylactic Antibiotic Administration
- Per cent of Patients with Appropriate Prophylactic Antibiotic Discontinuation
- Per cent of Surgical Patients with Appropriate Hair Removal
- Per cent of All Surgical Patients with Normothermia in PACU

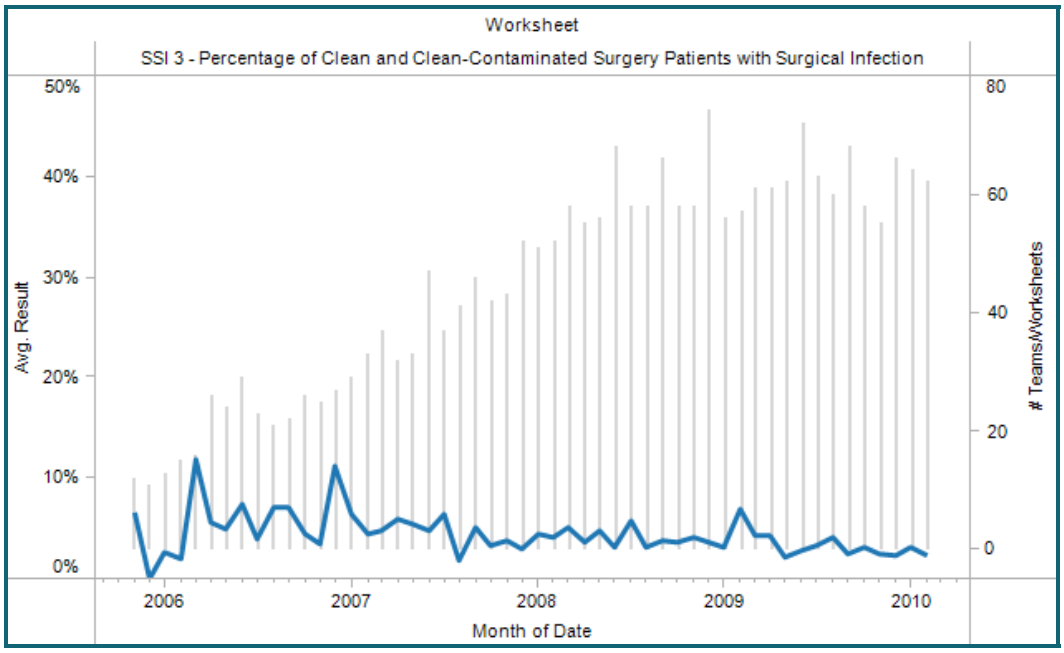
These processes that were measured over time demonstrated a significant overall improvement in surgical care safety. Participating organizations implementing best practice have reached and sustained the goal of appropriate hair removal in over 95 per cent of patients. Progress continues to be made with timely prophylactic antibiotic administration and discontinuation, as well as end-of-surgery normothermia.

The Surgical Site Infections Getting Started Kit highlights new and updated best practices. The intent of the *Safer Healthcare Now!* measurement team is to support teams across Canada by collecting data and providing feedback in a timely manner to help guide teams in their improvement efforts.

However, we recognize that teams with limited resources may find it difficult to achieve the required number of submissions; therefore, we recommend that at least all teams focus on three things:

1) Collect, submit and monitor data for all SSI indicators, where significant opportunity for improvement remains
2) Collect, submit and monitor data for normothermia and perioperative blood glucose control, as national compliance has not yet reached 95 per cent
3) Collect, submit and monitor data for timely antibiotic administration for caesarean section patients

Figure 1: Incidence of Surgical Site Infections in patients undergoing clean and clean-contaminated surgery in Canada from 2006 to 2010



Background

The Case for Preventing Surgical Site Infections

Surgical site infection is the most common healthcare associated infection among surgical patients, with 77 per cent of patient deaths reported to be related to infection.[1]

Such infections result in 3.7 million excess hospital days and US $1.6-3 billion in excess hospital costs per year.[3, 4]

In Western countries, between two to five per cent of patients undergoing clean surgical procedures and up to 20 per cent of patients having intra-abdominal surgical procedures will develop a surgical site infection.[2] Infected surgical patients are twice as likely to die, spend 60 per cent more time in the intensive care unit, and are five times more likely to be readmitted to hospital after initial discharge.[3]

Preventing Surgical Site Infection: Evidence Based Strategies

1. Perioperative Antimicrobial Coverage

Appropriate Use of Prophylactic Antibiotics

One of the most important interventions in preventing surgical site infections is the optimization of antimicrobial prophylaxis. Appropriate use of antibiotics has been shown to reduce the incidence of surgical site infections.[1, 5-16] Optimal use of antibiotics, with regard to indication, antibiotic choice, dose, timing, and duration will help prevent surgical site infections and minimize untoward consequences such as super-infections, adverse reactions, and emergence of resistance.[1] Unnecessary antibiotic use exposes patients to the possibility of super-infections such as *Clostridium difficile* and increases selective pressure on organisms leading to antimicrobial resistance.

Where are we now?

The Surgical Care Improvement Project (SCIP) reported the following US national averages for the fourth quarter of 2007. This data is self-reported by hospitals and subject to validation review:[17]

- Antibiotics are given within one hour of surgery 89.5 per cent of the time, on average (benchmark 99 per cent).
- Correct antibiotics are given 95.2 per cent of the time, on average (benchmark 99.5 per cent)
- Antibiotics are discontinued within 24 hours of the end of surgery 86.2 per cent of the time, on average (benchmark 98.2 per cent)

In Canada, there is no concerted effort to determine how antibiotics are used in prophylaxis. There are however individual efforts performed sporadically.[18,19]

- Correct antibiotics were given in 92 per cent[18] and 97 per cent[19] of cases
- Antibiotics were given in the appropriate time frame in 78 per cent of cases[18]
- Antibiotics are discontinued within the appropriate timeframe in 78 per cent of cases[18] and 34 per cent of cases[19]

It is recognized that documentation needs to be improved for a more accurate assessment.[19]

i. Indication

Antibiotic prophylaxis is indicated for patients at high risk of infection, when prosthetic material is being implanted, or in patients that would experience catastrophic consequences if an infection was to occur.[20,21] The National Healthcare Safety Network (NHSN) has developed an index that assesses the patient's risk for infection based on the pre-operative assessment (American Anesthesiology Assessment

Score), the level of contamination at the time of the procedure, the duration of the procedure, and the use of a laparoscope.
www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf

For example, antibiotic prophylaxis in clean surgeries is only indicated for cardiac, orthopedic, neurosurgery, vascular, and sometimes thoracic patients depending on the intervention. Recommendations to use antibiotics are based on this assessment index.

ii. Choice

The antibiotic selected for each procedure should provide coverage for the majority of organisms likely to be encountered during the procedure but it does not need to eradicate every potential pathogen to be effective. Local epidemiological/ antibiogram data, when available, should take precedence over published guidelines when selecting agents.

The selection of antibiotic for prophylaxis should also take into consideration the patient's colonization or infection with multi-drug resistant organisms.[22] For example, for patients with **known** *methicillin resistant Staphylococcus aureus* (MRSA) colonization or infection, consider **adding** vancomycin to the surgical prophylaxis regimen for high-risk procedures that involve a skin incision in cardiac, vascular and spinal procedures, as well as orthopedic procedures involving implants such as complex fractures/fractures with internal fixation and joint arthroplasties. Vancomycin alone is less effective than cefazolin for preventing surgical site infections due to *methicillin susceptible S. aureus* (MSSA).

It is important to determine whether the patient has a true penicillin or cephalosporin allergy in order to avoid unnecessary use of alternative prophylactic agents such as clindamycin or vancomycin. Patients should be considered to have a true allergy if they have experienced at least one of the following:

- respiratory difficulty, hypotension, or hives; or
- a severe non-IgE-mediated reaction, such as interstitial nephritis, hepatitis, hemolytic anemia, serum sickness, or a severe cutaneous reaction.

In the absence of these findings, cefazolin can be used as surgical prophylaxis.

iii. Appropriate Dosing

The goal of antimicrobial surgical prophylaxis with regard to dosing, timing, frequency, and duration is to achieve serum and tissue antibiotic concentrations that exceed the minimum inhibitory concentrations (MICs) of the majority of organisms likely to be encountered at the time of the incision, and for the duration of the procedure (**Table 1**).

There is limited published data on appropriate antimicrobial dosing for prophylaxis. The dosage of the antibiotic needs to be adequate based on the patient's body weight, adjusted dosing weight, or body mass index.[42] Additional doses may be necessary during prolonged surgery in order to ensure an adequate antimicrobial level is maintained in tissue until wound closure.

Weight-Based Dosing

Rationale and expert opinion point to the adoption of weight based dosing as an added strategy to lower SSI rates. There is evidence that applying weight-based dosing to cefazolin, aminoglycoside, and vancomycin surgical prophylaxis regimens will lower SSI rates among obese patients.[43-45] However, there are pharmacokinetic considerations that pose challenges when determining adequate dosages of antibiotics in obese patients.[46]

For cefazolin, the guidelines by Bratzler et al recommend increasing the dose from 1 g to 2 g for patients weighing more than 80 kg, and to 3 g for those weighing 120 kg or more.[23] However the recommendation to give 3 g is based on expert opinion and available evidence suggests 3 g is not necessary regardless of body mass index (BMI).[47] For simplification and because of the relatively nontoxic nature of cefazolin and the high percentage of obese surgical patients, some Canadian hospitals have standardized to 2 g cefazolin doses for all adult patients when antibiotic prophylaxis is indicated.

Data is inconclusive whether standard 1.5mg/kg dosing or high dose 5 mg/kg is necessary for gentamicin. ASHP/IDSA/SIS/SHEA guidelines recommend 5 mg/kg dosing but most evidence cited is for treatment with gentamicin, not prophylaxis.[23] The evidence cited for a higher gentamicin dose for prophylaxis came from one study in colorectal surgery where they compared 4.5 mg/kg single pre-op dose to 1.5 mg/kg given pre-op plus 3 postop q8h doses and found the single high dose at least as effective as multiple standard dose regimen.[45] They theorized that the single high dose might be more effective if surgery is delayed or prolonged.

The same author conducted a second pharmacodynamic study characterizing the importance of the "closure concentration" in preventing surgical site infections (SSIs). A critical concentration of 1.6 mg/L was identified.[44]

A gentamicin dose of 1.5 mg/kg would achieve peak levels of 6 mg/L if the patient had an average volume of distribution. Five hours later (if patient had normal renal function, i.e. $t_{1/2}$=2.5h), the gentamicin level would still be 1.5 mg/L (compare to average MIC_{90} for *E. coli* of 0.5-1 mg/L and critical closure concentration of 1.6 mg/L cited above).

It is therefore recommended that a 5 mg/kg single pre-op dose of gentamicin be used if post-op doses are indicated for the type of surgery to provide 24 hours of antimicrobial prophylaxis, or if the anticipated duration of surgery is greater than five hours. Otherwise, standard dose of 1.5 mg/kg is recommended for gentamicin pre-operatively. Gentamicin dose should be based on ideal body weight (IBW), or dosing weight (DW) if the patient's actual body weight is > 20 per cent above IBW, rounded to the nearest 20 mg.

Vancomycin doses should be based on total body weight, rounded to the nearest 250 mg, and to a maximum of 2 g/dose.

Table 1 provides suggested dosing, administration, and re-dosing of prophylactic antibiotics. Pediatric patients should receive weight-based doses unless the dose exceeds the recommended adult dose, in which case the adult dose should be used.

iv. Timing

Pre-operative systemic antibiotics (except vancomycin and fluoroquinolones) should be infused within 60 minutes prior to first incision, and ideally at the time of anesthetic induction.[22,23] To avoid Red Man Syndrome with vancomycin and hypotension with fluoroquinolones, these agents need to be infused over one to two hours so administration should begin within 120 minutes prior to first incision. The Red Man Syndrome usually appears four to 10 minutes after the commencement of the infusion, and is characterized by flushing that affects the face, neck and upper torso. Less frequently, hypotension and angioedema may also occur.

To best achieve this timing, antibiotics can be given in the operating room (OR) by the anesthesiologist at induction of anesthesia, but depending on the circumstances of the procedure and/or the facility, may also be given in the pre-op holding area, or on the patient care unit if prolonged infusion is necessary (see **Table 1**). Administering antibiotics "on call to the OR" is not recommended as it often results in suboptimal antibiotic concentrations due to surgery schedule changes, transport delays, or prolonged intra-operative preparation procedures.

Facilities that have reported high rates of success with timely prophylactic antibiotic administration assign responsibility to anesthesiologists in order to optimize timing of antibiotic delivery.[18, 24, 25]

It is recommended that all antibiotic infusions be completed no more than 60 minutes prior to first incision.[23] This allows time to achieve an adequate concentration of the antibiotic in serum and tissues at the start of surgery. If antibiotics are given too early, concentrations will not be sufficient to last throughout the operation.

Antibiotic Prophylaxis during Caesarean Section

Despite the use of antibiotic prophylaxis, infections are one of the five leading causes of pregnancy related mortality in the world.[27] A recent meta-analysis revealed that women undergoing a caesarean section (C-section) are five to 20 times more likely to get an infection compared with those who have a vaginal delivery.[28] Up to 80 per cent of caesarean section related infections go unrecognized due to onset of symptoms post-discharge and lack of outreach surveillance.[29, 30]

Several publications have shown a reduction in maternal infection rates when the prophylactic antibiotic was given within 60 minutes of incision vs. after cord clamping.[27, 31-33] WHO, the American Academy of Pediatrics, and the American College of Obstetricians and Gynecologists have indicated that administering prophylactic antibiotics during the hour before incision may be more effective than waiting until umbilical cord clamping.

Neonate. The neonatal concerns often cited to justify the practice of administering prophylactic antibiotics after cord clamping have not been validated by prospective trials. On the contrary, clinical trials have demonstrated no increase in neonatal sepsis, sepsis workups or neonatal intensive care unit (NICU) admissions.[33] More recent research has actually shown a decreased trend in NICU admissions in neonates whose mothers received antibiotics prior to skin incision.[32]

Evidence to practice. Based on the findings, a change in policy regarding the timing of prophylactic administration of antibiotics from post cord clamping to pre–incision was implemented in an academic center in the US in 2006.[35] An overall SSI rate reduction of 67 per cent, primarily due to a reduction in the incidence of endometritis, was achieved during the year following the change in timing of antibiotic prophylaxis to be administered before incision.

RECOMMENDATION

Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that prophylactic antibiotic administration be started and completed within 60 minutes prior to skin incision for C-sections instead of after cord-clamping.

Antibiotic Prophylaxis with Tourniquet Application

Governing bodies recommend that the complete dose of prophylactic antibiotics be infused prior to inflation of a tourniquet.[34,35,36] If the antibiotic is fully infused 30-60 minutes prior to incision, its effect will be maximized.[38,39] It seems intuitive that the entire antimicrobial dose should be infused before a tourniquet is inflated, or before any other procedure that restricts blood flow to the surgical site is initiated; however, a study of total knee arthroplasties compared cefuroxime given 10 to 30 minutes before tourniquet inflation with cefuroxime given 10 minutes before tourniquet deflation and found no significant difference in SSI rates between the two groups.[231]

Some researchers suggest that tourniquet use may impair the prophylactic efficacy of antibiotics administered before tourniquet inflation.[40, 41] They suggest that if the antibiotic is administered at the moment the tourniquet is released, the concentration of antibiotic in the blood bathing the wound would be high. Currently there is no conclusive evidence to indicate a change in practice.

RECOMMENDATION

Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that a prophylactic antibiotic infusion be started and completed within 60 minutes prior to tourniquet inflation for cephalosporins (cefazolin) and within 120 minutes for vancomycin and fluoroquinolones in order to maximize antibiotic efficacy.

Antibiotic prophylaxis for Cardiovascular Percutaneous Procedures

For the purpose of this document, percutaneous implantation of cardiac and vascular devices includes anti-arrhythmic and resynchronization devices, intracardiac closure devices, coronary stents, trans-catheter valve replacements (TAVI), percutaneous temporary ventricular/oxygenation support devices and endovascular stents and coils.

- Despite recent guidelines published in the US by the Society of Cardiovascular Angiography and Interventions,[65] there is no current literature to support the routine use of antibiotic prophylaxis for cardiac catheterization procedures including diagnostic, arrhythmia ablations and placements of stents (PCI).
- The common practice for implantation of all the other devices is to provide antibiotic prophylaxis, usually administered within the current recommended 60 minutes before the beginning of the procedure or skin incision[66]
- It is recommended that cefazolin 2 g IV should be the standard dose[67, 201]
- There is no evidence that additional doses of antibiotics are necessary

Antibiotic Prophylaxis for Trauma Patients

There is limited research that provides information on the appropriate timing of antibiotic prophylaxis for trauma patients. According to the Surgical Care Improvement Project (SCIP), the prophylactic antibiotic should be given within 60 minutes prior to skin incision and discontinued 24 hours after the surgery for trauma laparotomies.[68] For orthopedic trauma patients, current guidelines suggest that antibiotic prophylaxis be given within 30 to 60 minutes before the first surgical incision and discontinued 24 hours after the surgery.[69-72] There is no solid evidence to make specific recommendations.

v. Re-dosing

Re-dosing of antibiotics may be required during prolonged surgery (more than two half-lives of the antibiotic used) or procedures in which there is significant blood loss (more than 1.5 L) in order to maintain therapeutic levels perioperatively – see **Table 1** for recommended re-dosing of prophylactic antibiotics.

Evidence suggests this strategy will contribute to the reduction of surgical site infections.[1] Additional intra-operative doses may not be warranted in patients for whom the half-life of the antimicrobial is prolonged, such as those patients with renal insufficiency. Also, according to SHEA practical recommendations[228] in clean and clean-contaminated procedures do not administer additional prophylactic antimicrobial agent doses after the surgical incision is closed in the operating room, even in the presence of a drain.

Table 1 provides suggested dosing, administration, and re-dosing of prophylactic antibiotics. Pediatric patients should receive weight-based doses unless the dose exceeds the recommended adult dose, in which case the adult dose should be used.

Table 1: Recommended Doses, Administration, and Re-dosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis

Prophylactic antibiotic	Recommended adult dose	Recommended pediatric dose†	Recommended administration duration	Recommended timing of antibiotic administration	Recommended intra-operative re-dosing interval (from time of administration of pre-op dose)
Cefazolin	2 g*	30 mg/kg	IV push	Within 60 minutes before incision	q4h#
Cefuroxime	1.5 g	50 mg/kg	IV push	Within 60 minutes before incision	q4h#
Ceftriaxone	1-2 g	50-75 mg/kg	IV push	Within 60 minutes before incision	NA
Ciprofloxacin PO	500 mg	NA	PO	60 -120 minutes before incision	NA
Ciprofloxacin IV	400 mg	10 mg/kg	Administer over 60 minutes	Within 60 minutes before incision	NA
Clindamycin	600-900 mg	10 mg/kg	Administer over 20-30 minutes (max. 30mg/ minute)	Within 60 minutes before incision	q4-6h
Co-trimoxazole PO	1 DS tablet	NA	PO	60-120 minutes before cut incision	NA
Gentamicin	1.5 mg/kg** or 5 mg/ kg**	2.5 mg/kg	Administer over 30 minutes Administer over 60 minutes	Within 60 minutes before incision	NA NA
Metronidazole	500mg	15 mg/kg	Administer over 20 minutes	Within 60 minutes before incision	q8h
Vancomycin	15 mg/kg***	15 mg/kg	Administer ≤1g over at least 60 minutes, > 1g- 1.5g over at least 90 minutes, and > 1.5g over 120 minutes	Within 120 minutes before incision	q8h#

NA = not applicable/no literature available

† The maximum pediatric dose should not exceed the recommended adult dose.

* For adult patients with total body weight ≥ 120 kg, cefazolin 3 g IV is recommended by IDSA guidelines but is based on expert opinion. Available evidence suggests 3 g is not necessary regardless of body mass index (BMI).

** Use 5 mg/kg as a single pre-op dose if: post-op doses are indicated to provide ~24 hours of antimicrobial prophylaxis, anticipated duration of surgery is greater than five hours. Gentamicin dose should be based on ideal body weight (IBW), or dosing weight (DW) if the patient's actual body weight is > 20% above IBW, dosing should be rounded to the nearest 20mg.

*** Vancomycin dose should be based on total body weight, rounded to the nearest 250 mg up to a maximum 2 g/dose.

\# Additional intra-operative doses may not be warranted in patients for whom the half-life of the antimicrobial is prolonged, such as those patients with renal insufficiency.

vi. Duration

Single Dose Antibiotic Prophylaxis

Published literature on antibiotic prophylaxis shows that for the vast majority of non–complex and uncomplicated surgical cases a single dose of antibiotic is usually sufficient in preventing infections.[48-58] The Medical Letter Treatment Guidelines state the following: "The duration of antimicrobial prophylaxis should be <24 hours for most procedures." Canadian institutions are administering antibiotic prophylaxis up to 24 hours post-operatively only for few procedures including open heart surgery (coronary artery bypass graft and cardiac valve surgery), thoracic surgery (pneumonectomy, lobectomy, thoracotomy), gastrointestinal surgery (penetrating abdominal wound, oesophageal resection, colorectal surgery), and orthopedic surgery (hip or knee repair, open fractures). However, there is no data to support continuation of prophylaxis after wound closure or until all indwelling drains and intravascular catheters have been removed."[59]

a. Antibiotic resistance: Potential negative impact of prophylactic antibiotics

Studies have shown that approximately 15 per cent of all antibiotics in hospitals are administered for surgical prophylaxis.[22] While the administration of antibiotic prophylaxis during the 24-hour post-operative period does not affect the incidence of adverse effects, there are risks associated with administration of prophylaxis for more than 24 hours. Patients on prolonged antibiotic prophylaxis are more likely to develop *Clostridium difficile* infection (CDI) and harbour antibiotic resistant bacteria,[60-63] which underscores the importance of good antimicrobial stewardship.

Limiting the duration of surgical antibiotic exposure could help reduce the incidence of antimicrobial resistant organisms and other forms of collateral damage, such as CDI.[1,61,64] The literature suggests that while there are risks associated with antibiotic prophylaxis, the risk of developing a post-operative surgical site infection still outweighs the risk of developing CDI.

The *Safer Healthcare Now!* SSI Faculty encourages teams to continue with prophylaxis according to the recommended duration. An important balancing measure is to monitor side effects of prophylaxis by working with your infection control practitioners to monitor the incidence of antimicrobial resistance, CDI and surgical site infections.

What changes can we make that will result in improvement?

- Use pre-printed or computerized standing orders that specify the recommended choices for antibiotic drug, dose, timing, and discontinuation.
- Change operating room drug stocks to include only standard doses and standard drugs that reflect local agreed upon guidelines.
- Reassign antibiotic administration responsibilities to anesthesia (or pre-op holding area nursing staff) to improve timeliness and efficacy.

RECOMMENDATION

Based on the evidence, the *Safer Healthcare Now!* Faculty recommend that prophylactic antibiotics be completely infused within 60 minutes of first incision, and should be repeated for surgeries lasting longer than two half-lives of the antibiotic or those with significant blood loss.[23] This allows time to achieve an adequate concentration of the antibiotic in serum and tissues at the start of surgery. If antibiotics are given too early, concentrations will not be sufficiently maintained throughout the operation. Antibiotics administered for cardiac, thoracic, orthopedic and vascular patients should be discontinued within 24 hours of the end of surgery, whereas other surgeries require no further administration of prophylactic antibiotics following surgery.

b. Antiseptic Prophylaxis

Skin preparation plays a significant role in the prevention of SSI. A primary source of SSI in clean surgical procedures is the patient's skin bacterial flora.[73] The aim of skin preparation is to minimize the bacterial burden on the skin and prevent rebound growth without causing irritation to the surgical site.

Perioperative antiseptics are currently delivered in a variety of ways: mouthwash, body wash, skin preparation of the surgical site, as well as post-operative wound care. Acceptable antiseptic agents include chlorhexidine and iodophors (povidone-iodine), in combination with alcohol, if not contraindicted. The ideal pre-operative skin antiseptic agent should:

- significantly reduce microorganisms on intact skin,
- be non-irritating to the skin,
- be broad spectrum,
- be fast acting,
- have a persistent effect,
- remain effective in the presence of organic material (blood and body fluid), and
- be cost effective.[74, 75]

Although pre-operative bathing (whole-body disinfection) with antiseptic agents has not been shown to reduce the incidence of SSI rates,[1, 26, 89] it has been shown to reduce bacterial counts on the skin.[90] It is recommended that patients should shower or bathe with either soap or an antiseptic agent at least the night before the operative day.[204-212]

Chlorhexidine Surgical Skin Preparation

Alcohol-based antiseptics have demonstrated their superiority compared to non-alcoholic solutions. Therefore, intra-operative skin preparation should be performed with an alcohol-based antiseptic agent, unless contraindicated.[213-226]

Chlorhexidine and povidone-iodine are the most commonly used antiseptic compounds. While both are safe and effective for skin disinfection, two per cent chlorhexidine with 70 per cent isopropyl alcohol (2% CHG/70% IPA) has repeatedly been shown to be a more effective surgical skin preparation solution than any other bactericidal agent to which it has been compared.[76-80]

The properties that make chlorhexidine highly effective are a strong affinity for binding to the skin, high antibacterial activity, and a prolonged residual effect on rebound bacterial growth.[81] Alcohol-based chlorhexidine antiseptic solutions significantly reduce the likelihood of wound, catheter, and surgical site colonization and maximize the rapidity, potency and duration of bactericidal activity when compared to other solutions.[82]

Not only is chlorhexidine superior in reducing bacterial colony counts, but recent research has shown substantive evidence that alcohol-based chlorhexidine antiseptic solutions are superior to povidone-iodine in preventing surgical site infections.[78, 83-85]

Further, in contrast to iodophors, chlorhexidine does not become inactivated in the presence of organic material, such as blood, pus, and body fluids.[86] In order to maximize the effects of chlorhexidine, both the Society for Healthcare Epidemiology of America (SHEA) and the Infectious Disease Society of America (IDSA) recommend that chlorhexidine **not be washed off** following application.[87]

Caution with Alcohol-Based Solutions

Fire hazard. Fires in the OR can have devastating consequences for both patients and staff. While fires in the OR are extremely rare, alcohol-based antiseptics are flammable, therefore *Safer Healthcare Now!* Faculty recommend that the following precautions be taken when using alcohol-based antiseptic skin prep solutions:

- Provide education to all staff on the safe use and effective application methods before the use of all flammable alcohol-based solutions.
- Avoid dripping or pooling of alcohol-based antiseptic solutions on sheets, padding, positioning equipment, adhesive tape, as well as under the patient (umbilicus, groin).[74]

- Ensure the antiseptic solution has completely dried by evaporation – a minimum of three minutes is required for alcohol-based solutions.[34, 74] Areas with excess hair will take longer to dry. Healthcare facilities utilizing alcohol-based surgical preparation solutions should develop protocols to ensure and document that the applied solution is completely dry before draping the patient (i.e. add to pre-operative surgical checklist). Some sites across the country are using the "time out phase" of the surgical checklist to allow chlorhexidine-alcohol skin prep solution to dry. An ideal surgical checklist has three phases: briefing, time out and debriefing.
- Single–use applicators should ideally be used to apply flammable skin preparation agents. In addition, the FDA has recommended single-use packaging for all antiseptic products to further reduce the risk of contamination.[88] For head and neck procedures, use an applicator with less volume to avoid excess. This limits the amount of pooling on or under the patient and also reduce the risk of contact with eyes and inner ear, which is a contra-indication to alcohol-based solutions.[74]
- Surgical team members must communicate with each other when a flammable skin preparation agent is used.

Skin sensitivities/allergies

Chlorhexidine is well tolerated and has shown a low incidence of hypersensitivity and skin irritation.[82] Rare cases of severe allergic reactions, including anaphylaxis, have been reported.[91-93] Caution should be exercised to avoid direct contact with the eye,[94] inside of the ear[95] (to avoid vestibular and ototoxicity), or with neural tissue.

Children

Alcohol–based chlorhexidine solution (2% CHG/70% IPA) has been approved by the US FDA for children two months or older. The **compendium of strategies to prevent healthcare-associated infections** from the Society for Healthcare Epidemiology of America (SHEA) recommend that infants older than two months of age be bathed with chlorhexidine for the prevention of hospital acquired infections, specifically for prevention of central-line blood stream infections and to prevent MRSA transmission.[87] In May 2012, the FDA approved the following statement for inclusion in the labels of CHG products: "use with care in premature infants or infants under two months of age. These products may cause irritation or chemical burns."[96]

Neurosurgery

- Caution should be exercised to avoid CHG contact with the eyes, the inside of the ears, the meninges.[74] (AORN 2013)
- Povidone iodine remains the standard for neurosurgical procedures.

Trauma

When the situation is life-threatening and there is not enough time for alcohol-based solutions to dry before skin incision, an aqueous-based antiseptic solution should be used. However, remember that all antiseptic should be dried before skin incision. Drying is part of achieving maximal efficacy.

RECOMMENDATION

Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that the patient should shower or bathe with either soap or an antiseptic agent on at least the night before the operative day. Intra-operative skin preparation should be performed with an alcohol-based antiseptic agent, unless contraindicated. Two per cent chlorhexidine with 70 per cent isopropyl alcohol (2% CHG/70% IPA) has repeatedly been shown to be the most effective surgical skin preparation solution for intact skin.

Following application of chlorhexidine-alcohol skin preparation solution, surgical teams should allow at least three minutes for the skin preparations to air dry prior to first incision., or longer if there is excessive hair. Allowing time for the skin preparation solutions to air dry is imperative to maximize its efficacy and prevent a fire hazard. In addition, CHG-alcohol skin prep should not be washed off but left under the wound dressing to enhance its benefits. The skin antiseptic outside the dressing can be washed off without reducing the benefits of the skin preparation to the surgical site.

Alcohol-free solutions should be used as a skin preparation in emergent cases when there is not enough time to allow CHG-alcohol solution to completely dry before incision.

There are CHG aqueous solutions marketed for use in the oral cavity. Manufacturer's directions should be followed for all antiseptics.

CHG/IPA manufacturer's labels do not recommend contact with eyes, inner ear, mucous membranes or meninges.

c. Decolonization

Mupirocin nasal ointment

Surgical site infections can double the risk of mortality among patients post-operatively.[97] *Staphylococcus aureus* is the most common bacterial cause of SSI[98] and can frequently colonize the anterior nares[99] and other body sites. Mupirocin nasal ointment has the ability to nearly suppress S. *aureus* from the nasal sites. In one study, there was a 56 per cent reduction in the rate of surgical site infections in the mupirocin-chlorhexidine group compared to the placebo group.[85] A systematic literature review by Kallen et al (2005) found that nasal decolonization decreases surgical site infections in non-general surgery cases, but not in general surgery cases.[100] In another intervention, Rao et al. demonstrated that 26 per cent

of the patients that tested positive for *S. aureus* completed the decolonization protocol and had no post-op infections at one-year follow-up.[101]

Photodynamic Therapy

Photodynamic Therapy (PDT) has also been shown to be an effective decolonization method. In preliminary human testing, PDT eradicated MRSA completely from the nose within 10 minutes.[102] An advantage of photodynamic therapy stems from its mechanism of action that involves **singlet oxygen** (electronically excited state of molecular oxygen) generation that makes it impossible to induce effective resistance mechanisms.[103] In a study by Bryce et al (2013), patients who were decolonized with the combination of PDT and Chlorhexidine Gluconate wipes were much less likely to have an SSI (51/3398) compared to the non-decolonized group (24/443) ($p<0.0001$; OR = 3.759). There was also a 50 per cent reduction in *S. aureus* infections in the decolonized group as well.[104]

The concern with the use of PDT for SSIs is how to eliminate the pathogens without damaging the host tissue and without compromising the local protective mechanism initiated by the very existence of the pathogens.[105] One way to ensure that the photosensitizer binds as much as possible to microbial cells and as little as possible to host cells is to deliver the photosensitizer directly into the infected area by topical application to skin or mucous membranes, instillation into a hollow organ, or by local injection into an abscess.[106]

d. Antiseptic Coated Sutures

Surgical sutures can be a contributing source of bacterial colonization and surgical site infections.[191] Sutures coated with antiseptic agents (**Triclosan** most commonly used) have been recommended to reduce the rate of SSIs.[191] A recent systematic review and meta-analysis of 17 Randomized Controlled Trials assessed 3,720 patients undergoing a variety of surgeries (breast, cardiac and other contaminated/dirty operations). [192] In the overall results, it was shown that Triclosan-Coated Sutures (TCS) reduced the rate of SSIs by 30 per cent.[192] In another comprehensive study by Nakamura et al (2013), it was reported that 4.3 per cent of elective colorectal surgery patients (9/206) had an SSI in the TCS group compared to 9.3 per cent (19/204) in the control (non-coated) group.[193] Future plans regarding antiseptic sutures include investigating the potential development of bacterial resistance and cost-effectiveness of the TCS.

RECOMMENDATION

Antiseptic coated sutures (ACS) have been associated with a reduction in SSIs; although the impact of ACS on antiseptic resistance remains to be elucidated. Therefore, "Do not routinely use antiseptic-impregnated sutures as a strategy to prevent SSIs".[228]

2. Appropriate Hair Removal

The use of razors (shaving) prior to surgery increases the incidence of wound infection when compared to clipping, depilatory use, or no hair removal at all.[82, 107-111] According to WHO guidelines,[37] hair should not be removed unless it interferes with the surgical procedure. The literature indicates that clipper use is sufficient for any body part and that razor use is not appropriate for any operative site. Clippers should be used as close to the time of surgery as possible.[1]

Depilatory cream is a potential option, but has some disadvantages. They may require an allergy and irritant patch test 24 hours before the full application. Also, hair removal using a depilatory cream would have to be carried out in the patient's own home due to reduced pre-admission time.[112]

What changes can we make that will result in improvement?

- Patients should be educated not to shave or use a depilatory agent in the vicinity of the surgical site before surgery.[74] Incorporate this message into the printed pre-operative patient information and surgeon's office communication.
- Update policy and procedure manuals: If hair removal is necessary, clippers should be used instead of razors to prepare the surgical area pre-operatively
- Remove all razors from the hospital once clippers have been introduced. Work with the purchasing department so that razors are no longer purchased by the hospital
- Implement reminder posters throughout the operating theatre and surrounding patient support areas
- Involve staff in the selection of clippers
- Use either a single-use electric or battery-powered clipper, or a clipper that can be fully submersed and disinfected between patient use with disposable or re-useable heads[74]
- Clipping should occur less than two hours before surgery in an effort to limit bacterial contamination of the surgical site[37]
- The AORN guidelines report that hair should be removed outside of the operating room theatre or procedure room to limit hairs from contaminating OR tables and/or the surgical wound.[74] We recognize that this is a challenge given that most OR departments do not have private facilities to remove hair outside the operating room theatre
- We caution against removing hair on the units prior to surgery as it increases the likelihood of falling outside of the two-hour window

- It may be necessary to remove hair in the operating room theatre or on a gurney in an OR holding area. Regardless of location, using adhesive gloves or other methods to remove stray hairs after clipping is important

RECOMMENDATION

Safer Healthcare Now! **SSI Faculty recommends no hair removal prior to surgery. If hair removal is necessary, clippers (not razors) should be used. Ideally, hair removal should occur outside of the OR theatre or procedure room, but inside of the operating room department, within two hours of surgery. OR teams should make every effort to reduce the risk of bacterial contamination of the surgical site by eliminating stray hairs following hair removal. A variety of methods, such as showering, using wipes or adhesive tape will help in eliminating hairs.**

Neurosurgery

- A systematic review found no statistical difference in infection rate between patients who were shaved or not shaved for cranial procedures[113]
- Sparing the hair has considerable cosmetic value for the patient
- Strategies for managing hair in neurosurgery cases include:[117]
  - Braiding[74]
  - Parting the hair with a sterile comb and taping it[114]
  - Binding hair with rubber bands for patients with long hair[115,116]
- "Because hair removal neither contributes benefits to the surgery itself nor decreases the risk of wound infection but does have considerable cosmetic value for the patient, many authors recommend that cranial surgeries should be done without hair removal."[113]
- Considerations for not removing hair include:
  - Wound closure may take 20-30 minutes longer than in shaved patients[118, 119]
  - Hair removal allows better visualization of underlying cranial defects, facilitation of markings, and avoidance of working around the hair[120]
- Removing hair remains the standard for neurosurgical procedures in Canadian hospitals

3. Maintenance of Perioperative Glucose Control† **

There is considerable observational evidence linking hyperglycemia[1] in hospitalized patients (with or without diabetes) to poor outcomes. Review of medical evidence shows a correlation between the degree of hyperglycemia in the post-operative period and the rate of SSI in patients undergoing major cardiac surgery.[121,122] Recent literature has informed that glucose control in all patients reduces the risk of infection.[123,124] Previous research has endorsed strict glycemic control (blood glucose levels within a low, narrow range) perioperatively.[125] However, the optimal glycemic control regimen to prevent SSIs has recently been questioned. Not only has there been no consistent reduction in mortality with strict control of glycemia in critical care patients,[126, 127] it has actually led to higher rates of hypoglycemia and increased mortality.[128, 129] Furthermore, a recent Cochrane meta-analysis found insufficient evidence to support the routine adoption of strict glycemic control (4.1-6.0mmol/L) over conventional management (<11.1 mmol/L) perioperatively for the prevention of SSIs.[130**]

Based on evidence, the American Association of Clinical Endocrinologists and the American Diabetes Association have recently released a consensus statement on glycemic control in hospitalized patients.[131] In the intensive care unit (ICU), intravenous infusion is the recommended route of insulin administration for persistent hyperglycemia. However, strict blood glucose levels (<6.1 mmol/L) should be avoided, and blood glucose should be maintained between 7.8 and 10 mmol/L for the majority of critically ill patients. Frequent glucose monitoring is essential to achieving optimal glucose control. Outside of the ICU, scheduled subcutaneous administration of insulin, with basal, nutritional, and correction components is preferred. However, during surgery patients should be treated as in an ICU.

Blood glucose targets before meals should be <7.8 mmol/L (and >3.9 mmol/L), and random blood glucose values should be <10 mmol/L. (See SSI Individual Risk Factors)

The Enhanced Society After Surgery recommends the use of strategies to minimize the stress of surgery and to protect against insulin resistance [232] which includes avoidance of pre-operative fasting, and use of epidural anesthesia to promote early post-operative alimentation.[233]

What recommended changes can we make that will result in improvement?

- Begin glucose maintenance protocols 24 to 48 hours before surgery – develop protocols to advocate that patients and families control their pre-operative glucose levels at home, including referral to a nutritionist
- All diabetic patients, or patients with risk factors for diabetes should have a capillary blood glucose (CBG) level drawn during their pre-operative clinic visit

[1] Hyperglycemia is defined as any blood glucose value >7.8mmol/L; hypoglycemia is defined as any blood glucose level <3.0 mmol/L) (Moghissi et al., 2009)

- All diabetic patients, or patients with risk factors for diabetes should have a capillary blood glucose (CBG) level drawn during their pre-operative clinic visit
- Assign responsibility and accountability for blood glucose monitoring and control
- Diabetics, and anyone with a CBG >10 mmol/L should be flagged to have a repeat CBG drawn the day of surgery (these patients should have CBG done every two hours intra-operatively)
- CBG >10 mmol/L perioperatively – notify anesthesiologist or surgeon
- Patients should be informed that glucose levels should be maintained until at least 24 to 48 hours after surgery[130, 195] and monitored every one to four hours if the patient is diabetic.[127]

RECOMMENDATION

Based on the evidence, The *Safer Healthcare Now!* SSI Faculty recommends that perioperative blood glucose levels be monitored on all surgical patients who are diabetic or have risk factors for diabetes. Teams are encouraged to apply conventional glucose control (BG < 10-11 mmol/L) to surgical populations. Strict perioperative glycemic control (4.1-6.0mmol/L) should be avoided to enhance patients' outcome. Blood glucose should not drop below 6.1mmol/li.

4. Perioperative Normothermia[§]

It is well established that General and Neuraxial Anesthesia impair thermoregulatory control. Consequently, between 50 per cent to 90 per cent of the surgical population who are not actively warmed will become hypothermic intra– and post-operatively.[132,133] In addition to impaired thermoregulation, Anesthesia induces a heat redistribution followed by heat loss secondary to wet skin preparations and skin exposure to cold operating rooms which allows heat loss by convection, conduction, evaporation and radiation. Heat redistribution is minimized when heat content of the peripheral compartments is increased by **pre-warming** patients before they enter the OR. Pre-warming entails using the same forced-air system that is currently used in the OR suites, however it should be initiated before patients are admitted to the OR theatres.

The medical literature suggests that patients undergoing surgery have an increased risk of surgical site infection if normothermia is not maintained during the perioperative period.[133,134] The association between hypothermia and SSI is supported by the following mechanisms:

- Hypothermia directly impairs immune cell function.
- Hypothermia triggers vasoconstriction, which reduces blood flow and oxygen partial pressure at the surgical incision.

Mild perioperative hypothermia has also been associated with a 16 per cent increase in blood loss, 22 per cent decrease in transfusion requirement,[135] triple the number of cardiac complications in a population at risk of coronary artery disease undergoing major surgery[136] and prolonged anesthesia recovery time and hospital stay.

These complications can be reduced through the implementation of perioperative thermal management and continuous intra-operative temperature monitoring which **should be done for any surgery scheduled to last more than 30 minutes.[137]**

Normothermia entails keeping the patient's core temperature at or above 36°C, as patients go through their surgical procedure. *Safer Healthcare Now!* defines normothermia as maintaining a core temperature between 36°C to 38°C. It is essential to monitor core body temperature optimally. The gold standard body sites for assessing core temperature are the pulmonary artery, the distal esophagus[137] and nasopharyngeal sites. However, other less invasive sites can be used particularly when patients are awake. Therefore, oral, infra-red temporal and tympanic thermometers are capable of measuring temperatures if properly utilized (well trained clinician). However, among the non-invasive thermometers, oral temperature probes provide more accurate readings.[137]

What kind of changes can we make that will result in improvement?
Normothermia (core temperature 36°C to38°C) should be maintained pre-operatively, intra-operatively, and in PACU by implementing any combination of the following:

- Pre-printed order sets to ensure pre-warming
- Active Pre-warming AND Intra-op warming is indicated when surgery is expected to last >30 minutes[137]
- Warmed Intravenous fluids for abdominal surgeries expected to last more than one hour in duration[137]
- Warmed lavage liquids for colorectal surgery
- Increase the ambient temperature in the operating room to 20°C to 23°C (ORNAC standards)[138]
- Hats and booties on patients during surgery
- Pre-warming should be initiated between 30 minutes to two hours prior to major surgery. Recent literature has shown that even only 10 minutes of pre-warming makes a difference.[139] The optimal duration of pre-warming has not been determined.

RECOMMENDATION

Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that measures are taken to ensure that surgical patient's core temperatures remain between 36.0°C and 38.0°C pre-operatively, intra-operatively, and in PACU. Continuous intraoperative temperature monitoring is suggested anticipating that 50 to 90 per cent of surgical patients will become hypothermic if not actively warmed. Active pre-warming and intraoperative warming with forced-air are indicated for all surgeries schedule to last 30 minutes or more. Fluid warmers should be used if the surgical procedures is planned to last more than one hour. The ambient ORs room temperature should be maintained between 20°C to 23°C.

Canadian Story: Normothermia

In combination with several other SSI prevention initiatives, Sunnybrook Health Sciences Centre surgical and peri–anaesthesia teams set a goal to ensure all elective laparotomy patients maintain a core body temperature of at least 36°C perioperatively (no more than 38°C).

The following processes were implemented in an effort to achieve this goal:

A) Pre-warming

- Educate patient service partners from Same Day Surgery area on which surgical procedures were eligible for warming prior to surgery
- A checklist of surgical procedures that require a forced air blanket pre-operatively was established
- Revised pre-operative pre-printed order sets to include pre-warming for all major laparoscopic and laparotomy general surgery and surgical oncology procedures

B) Intra-operative warming

- Quarterly feedback on group performance to the OR teams
- Individual surgeons and anesthesiologists provided with feedback on their compliance with this best practice
- Automatic room temperatures set at 23°C at 7:15 am by default. After one hour, the OR room temperature control is given back to each OR. End-of-surgery temperature is recorded for all surgical cases. Periodic feedback is forwarded to healthcare providers
- Fluid warmers used for surgery lasting more than one hour where a greater amount of fluid is expected to be infused

Perioperative Temperature Control in Cardiac Surgery

Induced hypothermia has been used as an organ protective strategy since the beginning of cardiac surgery. However, unintended consequences have been associated with this practice. In addition, rewarming patients before weaning from Cardio-Pulmonary Bypass (CPB) has been associated with poorer neurocognitive outcomes.[140] According to Belway (2011),[141] in Canada, the vast majority of cardiac surgeries done with the assistance of CPB are done at a central core temperature of 34°C during the CPB. It is also common practice in Canada to rewarm patients to 37°C before weaning form CPB.[141] However, if no additional thermoregulatory strategies are implemented, a temperature drop of 1.2°C[203] is expected to happen from the time the patient is weaned from CPB until transfer to ICU. Consequently, patients may arrive in ICU with a temperature lower than 36°C, which has been shown to increase myocardial damage,[142] blood loss by 50 per cent,[143] mortality, prolonged hospital length of stay and delayed extubation.

In some centers, Off-Pump Coronary Artery Bypass Graft (OPCABG) surgeries are performed. Similarly to surgery performed with the assistance of CPB, OPCABG surgery patients also benefits from being normothermic. Normothermic patients at the end of surgery translates in a reduction of post-op blood loss by more than 40 per cent.[144]

RECOMMENDATION

According to Teodorczyk,[145] an underbody forced-air system blanket should be used during the rewarming phase on CPB and continued until transfer to ICU. This resulted in 90 per cent of cardiac surgical patients in the intervention group to arrive normothermic in ICU as opposed to 40 per cent in the control group. Similar evidence exists for OPCABG. Therefore, the *Safer Healthcare Now!* SSI Faculty recommend the use of a skin-warming surface technology (Forced-Air warming system being the most commonly studied and used) for all cardiac surgery cases with or without the assistance of CPB.

Canadian Pediatric SSI Journey – B.C. Children's Hospital

BC Children's Hospital (BCCH) began participating in the National Surgical Quality Improvement Program-Pediatrics (NSQIP-P) in May 2011. They receive semi-annual reports, which allow them to monitor their SSI rates and compare them with 56 other major pediatric centers in the United States. BCCH is the first and only Canadian pediatric site to participate at present. In being able to identify areas for quality improvement initiatives through NSQIP-P, they have established multiple projects that are ongoing to help tackle surgical site infection rates. The ability to target interventions was further enhanced by conducting two in-depth multivariate analysis studies (one matched for procedure, one unmatched) from which they were able to identify populations, who were most at risk, as well as any site-specific risk factors (e.g. prophylaxis administration of antibiotics, length of procedure, etc.)

BCCH started to decrease their SSIs by developing a clinical pathway for appendectomies based upon best evidence available for pediatrics, and consensus at their site. This included initial fluid management, pre-operative antibiotics, surgical antibiotic prophylaxis, and standardized skin preparation and post-operative care practices. Pre-operative medical treatment with antibiotics is commenced once a decision to operate is made. Re-dosing for surgical prophylaxis is provided if more than two (antibiotic-specific) half-lives have elapsed since the previous dose. This ensures optimized serum levels of antibiotic and avoidance of drug toxicity. Also in the field of pediatric surgery, they have an ongoing initiative revolving around gastroschisis, involving all aspects of the care of these neonates from birth through to discharge.

Further to the work being done with Pediatric Surgery, BCCH has also completed work looking at hypothermia in the orthopedic spine population, leading to a more advanced monitoring of hypothermia in the OR. In addition to their "Maintenance of Normothermia Policy" published in 2007 and revised in 2013, BCCH added pre-warming for non-cardiac cases slated to last more than two hours in 2010, for children over 10kg, with a temp check q30 min. In spinal surgical procedures, pre-warming substantially reduced the percentage of time during the case that patients were hypothermic.[202] The NSQIP-P team at BCCH has also taken a unique look at the relationship between nutrition and surgery by completing a pilot study looking at nutrition status of pre-operative orthopedic patients by utilizing their BMI and height z-scores. They are also working on validating a pre-operative nutrition assessment tool to identify those patients at high risk.

BCCH is in the early stages of introducing a chlorhexidine washcloth for pre-operative bathing practices in high-risk surgical patients. The NSQIP-P team is also working closely with the antimicrobial prophylaxis team, looking into more appropriate antibiotic use pre, intra and post-operatively. Ongoing monitoring of post-operative complications through NSQIP-P continues to be a positive and beneficial experience.

Enhanced Recovery After Surgery (ERAS)

Enhanced Recovery After Surgery (ERAS) is gaining momentum across Canada with a primary focus on colorectal surgery. ERAS is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery. It is designed to provide between 16 to 35 evidence-based elements for patients (depending on the surgical specialty) throughout the entire perioperative process. Some of the elements overlap with the recommendations in this Getting Started Kit, which highlight appropriate antibiotic prophylactic timing, normothermia and nutrition. The majority of research has focused on colorectal surgery and a recent meta-analysis found that compared to traditional care practices, those who have gone through the ERAS pathway could expect a decrease of 2.44 days from their primary hospital stay.[199]

ERAS has also has been shown to decrease surgical site infections from 11.5 per cent to 4.9 per cent, deep surgical site infections from 6.6 per cent to 1.6 per cent and urinary tract infections from 6.6 per cent to zero.[200] The biggest challenge reported with the implementation of ERAS were change management elements post-surgery for ambulation, early feeding and prophylactic intervention for nausea/vomiting and pain control.

There are four ways that sites across Canada are supporting the measurement framework for ERAS; these are:

- The National Surgical Quality Improvement Program (NSQIP) has built an ERAS module of 17 evidence based data elements for colorectal surgeries (but likely will expand to other surgical specialties)
- iERAS through the Best Practices in General Surgery at the University of Toronto. Link: http://www.bpigs.ca/eras-tools (costs associated with the purchase of this framework)
- The ERAS Society. Link: http://www.erassociety.org (costs associated with the purchase of this framework)
- Many sites are using a self-designed excel spread sheet.

Even though the majority of research on EARS started in colorectal surgical patients, many sites across Canada are applying pathways in other surgical specialities (i.e., neurology, urology and orthopaedics).

National Surgical Quality Improvement Program (NSQIP)

We have seen a growing interest in measuring risk adjusted surgical outcomes using the National Surgical Quality Improvement Program (NSQIP) across Canada. Thirty Canadian hospitals and more each month have enrolled in NSQIP. NSQIP provides validated and risk adjusted surgical outcomes data for almost 400 hospitals using the benchmark 30-day post-procedure patient follow-up. It is a program highly regarded by physicians for its rigour and benchmarking capacity.

Despite the focus on preventing SSI, the NSQIP hospitals have learned there is plenty of room for improvement. As hospitals strive to be in the top performing subgroup, many sites are meeting 'as expected' performance targets. There are several hospitals in the lowest performing subgroup for SSIs in one or all of their surgical sub-specialties.

SSI remains one of the key areas needing improvement across surgical programs in Canadian Hospitals. SSI rates are now being measured more systematically along with other adverse surgical outcomes such as urinary tract infection (UTI) and pneumonia. Few sites are performing at the exemplary level and many are in the bottom 30 per cent of the 375 comparison hospitals.

Health Economics

When focusing only on healthcare associated surgical site infections, three studies reported the average cost per case of surgical site infections in the general patient population to be US$1,051 (CAN$1,174),[146] €1,814 (CAN$3,268),[147] and 19,638 Swiss francs (CAN$21,392).[148]

In orthopaedic surgery patients, the median attributable cost of surgical site infection was US$17,708 (CAN$ 19,779).[149] Surgical site infections in patients after colorectal, head-and-neck cancer-related surgeries, coronary artery bypass graft, and low transverse caesarean section deliveries were associated with costs of US$13,746 (CAN$16,560),[150] €16,000 (CAN$26,273),[151] AUS$12,419 (CAN$14,934),[152] and US$2,852 (CAN$3,107) to US$3,529 (CAN$3,845) [153] per case, respectively.

Additional Hospital Length of Stay due to postoperative SSI (in Days)

Authors (Year)	Types of Surgery	Additional Hospital Length of Stay
Kasatpibal et al[154] (2005)	Various	14 days (median)
Weber et al[155] (2008)	Various	16.8 days (mean)
Alfonso et al[156] (2007)	Various	13.8 days (mean)
Coello et al[157] (2005)	Various	11.6 days (mean)
Coskun et al[158] (2005)	Cardiothoracic	28 days (mean)
Penel et al[159] (2008)	Head and Neck Cancer	16 days (mean)
McGarry et al[160] (2004)	S. *aureus* infections	11 days (median)

The additional hospital length of stay due to surgical site infections ranged from 11 to 28 days depending on the type of surgery.

SSI Individual Risk Factors

There are various patient related risk factors that increase the risk of developing an SSI that can be easily addressed with proper planning, anticipation and patient compliance. The major individual risk factors include:

1) **Obesity**[161]
2) **Malnutrition**[161]
3) **Smoking**[161]
4) **Pre-existing body site infection**[161]

1) Obesity

A Body Mass Index greater than 30 kg/m[162] can significantly increase the risk of acquiring a surgical site infection. Firstly, obesity is often associated with diabetes mellitus and increased serum glucose levels amplify the risk of developing infection.[161] Secondly, obese patients possess excess skin flaps that can cause prolongation of the surgical procedure. This can subsequently increase the risk of an infection.[162] Support from family and staff in adopting healthy eating habits and other life style changes can help patients lose weight and are encouraged. Educational sessions and nutritionist assistance can have positive effects for these patients.[161] Finally, patients with increased weight require higher doses of antibiotics to achieve effective tissue and serum concentration in order to reduce the risk of infection. In one study, morbidly obese patients who received 2 g rather than 1 g of cefazolin pre-operatively showed a 66 per cent decrease in the incidence of wound infections.[162]

2) Malnutrition

In patients with moderate and severe malnutrition,[171, 234, 235] wound healing is compromised and post-operative complications are significantly increased. Malnourished patients are at a higher risk for SSI.

Malnutrition includes both the deficiency and excess (or imbalance) of energy, protein and other nutrients. In clinical practice, under-nutrition, and inadequate intake of energy, protein and nutrients, is the focus. Under-nutrition affects body tissues, functional ability and overall health. In hospitalized patients, under-nutrition is often complicated by acute conditions (e.g. a trauma), infections and diseases that cause inflammation. Such complications worsen under-nutrition and make it more challenging to correct due to extensive physiological changes and increased nutritional needs when appetite is decreased.[236]

All patients should be screened for malnutrition either prior to or within 24 hours of admission using a validated nutrition screening tool. Ideally in a surgical population, patients should be screened early enough to allow for adequate nutritional rehabilitation prior to surgery; consideration to provide adequate nutritional support should be given for patients with severe malnutrition undergoing elective surgery.[171, 237] Patients with moderate malnutrition should be closely monitored by a dietitian/nutritionist in the post-

operative period so that timely and sufficient nutrition can be provided.[172, 238] See the **Nutrition** section.

3) Smoking

Cigarette smoking compromises wound healing by obstructing the accumulation of platelets in the micro-vascular region and increasing non-functional hemoglobin, thus decreasing circulation to the skin.[173] Smoking can also inhibit the immune system and reduce the delivery of oxygen to the surgical site.[161] In one study, non-smokers had an SSI rate of two per cent compared to 12.6 per cent in the group of smokers. There was also a significant (94.9 per cent) decreased incidence of infections after the group of smokers stopped smoking compared to the group that continued smoking.[162] Smoking cessation is recommended at least 30 days before surgery. Even if a patient stops smoking 24 hours before surgery, the oxygen carrying capacity of the blood is increased and the wound healing capabilities are less compromised.[227] These patients should also focus on their nutritional status because malnutrition is also associated with smoking.[161]

4) Pre-existing body site infection

Some patients may have soft tissue infections at the time of surgery. If these existing infections are located near the surgical site, the risk of developing an SSI increases three to five times.[161] Even in the presence of remote infections, haematogenous seeding may occur at the surgical site.

SSI Impact on Patient's Perspective and Quality of Life

Patient-focused care is the central driver in a healthcare setting and improving their long-term quality of life is of vast importance. SSI is one of the most devastating adverse events that can affect the patients' quality of life after surgery. Quality of life is rarely taken into account when we assess surgical morbidity.[174] The contributing factors include: increased requirement for home healthcare providers,[174] physical role functioning,[174, 175] emotional role functioning,[174, 175] social functioning,[175] bodily pain,[175] mental health,[175] vitality and general perception of health.[175]

A study by Whitehouse et al. displayed a significantly higher score (SF-36 patient based health outcome assessment) in patients' physical functioning, social functioning, bodily pain and general health perceptions in the SSI group compared to the control group who did not develop an SSI.[175] In another study, patients with SSI reported significant decline in physical and mental health and were 30 per cent more likely to require home healthcare providers.[174]

Safer Healthcare Now! recommends daily patient assessments of quality of care. The patient's perspective of good quality care during their stay in the hospital includes independent patient focused care related to their needs and sufficient commitment, care and concern from the staff.[176]

Recommendations for Patients

- Nutrition is important for wound healing. If you have lost weight before your surgery, make sure you inform your doctor and ask to be referred to a dietitian. If your appetite does not return to normal, or if you are losing weight after your surgery, contact your physician and ask to see a dietitian.
- Always consult with your physician about past medical and medication history
- Glucose control 48 hours before and after surgery / Diabetic and obese patients should always monitor and control the blood sugar levels
- No smoking for at least a month before surgery
- Do not shave near the surgical site
- Notify your physician if any skin infection, rash or sores are detected prior to surgery
- Ensure that care providers, family and friends are practicing appropriate hand hygiene (care providers should wash their hands before and after touching you or your environment)
- Ask if antibiotics are being administered prior to surgery
- Ensure staff provide clear instructions regarding the care of your surgical site incision and dressing before you are discharged

- Make sure you have been given contact information of an appropriate healthcare provider for any questions or problems while at home
- Inform the physician immediately, if any symptoms of infection, such as fever, redness, or pain at the surgical site are noted

Nutrition

The components of care described in this GSK cannot be taken out of the continuum of care and the effectiveness of the efforts deployed to implement these measures could be reduced if basic perioperative care is not provided.

Recovery from surgery is characterized by increased protein catabolism and turnover in tissues involved in the inflammatory response; wound healing is compromised and post-operative complications, including SSI, are significantly increased in patients with moderate and severe malnutrition.[171, 234, 235] The prevalence of this condition is high: a large Canadian study confirms that 45 per cent of patients are already suffering from moderate or severe malnutrition on the day of their admission to medical and surgical wards.[239] However, malnutrition is widely unrecognized; only 1.2 per cent of malnourished patients are identified by the surgical teams).[240]

Screening for malnutrition

Due to the failure of clinicians to identify malnourished patients and the negative impact of malnutrition, mandatory screening is the norm in the USA[241] and in Europe.[242] All patients should be screened for malnutrition either prior to, or within 24 hours of admission[171, 235, 243] with a validated screening tool such as the Canadian Nutrition Screening Tool[244] (CNST) which was validated for use by personnel both trained and not trained in nutrition. To date, this tool is superior to previously published tools for trained and untrained personnel.[245] This simple two questions tool is available for download at www.nutritioncareincanada/resources/ and can easily be incorporated in admission and pre-admission questionnaires. The goal is to intervene in a timely and adequate fashion in order to restore the nutritional status of surgical patients and to avoid adverse events such as SSI.

Preoperative nutrition [232, 237, 246-252]

- **Routine use of preoperative artificial nutrition** is not warranted, but significantly malnourished patients should be optimized with oral supplements or enteral nutrition before surgery. A recent study[253] confirmed that the lack of enteral nutrition pre-operatively negatively impacts the Gut-associated lymphoid tissue (GALT) and confirmed a close association between these changes and infectious complication morbidity.
- **Preoperative parenteral nutrition** is indicated in severely undernourished patients who cannot be adequately orally or enterally fed

- **Combinations of enteral and parenteral nutrition** should be considered in patients where there is an indication for nutritional support and >60 per cent of energy needs cannot be met via the enteral route, or in patients in whom partly obstructing benign or malignant gastro-intestinal lesions do not allow enteral re-feeding. In completely obstructing lesions, surgery should not be postponed because of the risk of aspiration or severe bowel distension leading to peritonitis
- **Preoperative fasting** should be limited to two hours for clear fluids and six hours for solids. Prolonged fasting does not prevent aspiration and reduces nutritional intake.
- **Carbohydrate loading[246] in the hours preceding** surgery has been shown to decrease thirst, insulin resistance and to help maintain lean body mass and muscle strength after surgery. Preoperative carbohydrate loading using the oral route is recommended in most patients. When patients cannot eat or are not allowed to drink preoperatively, the intravenous route can be used. The effect of carbohydrate loading in diabetic patients is reported to be safe.

Pre-operative immunonutrition

The inflammatory response to surgical stress impairs the immune system. This impairment may be due to depletion of essential nutrients playing a key role in immune function. Post-operative complications may arise including wound infections. Nutrients that have been identified to modulate the immune system include Omega-3 essential fatty acids (EPA, DHA), arginine, glutamine, nucleotides and antioxidants like selenium.[254, 255, 256] Omega-3 fatty acids attenuate the production of inflammatory prostaglandins and prostacyclins, and also reduce toxicity of inflammatory cells by replacing Omega-6 fatty acids in cell membranes.[254, 255] Arginine deficiency occurs as a result of surgical injury. Because arginine is a precursor to nitric oxide, it is an immune-modulating nutrient. It is also a precursor of purine and polyamines which help tissue repair and wound healing.[254]

There is great heterogenicity in the studies examining the use of immunonutrition (IN) and the outcome of surgical patients. Aside from surgical sites, study differ on content of IN (single nutrient or multi-ingredient IN), control groups (IN vs standard diet, IN vs standard oral nutrition supplementation), peri-operative phase (pre-op, peri-op, or post-op only), population of subjects (critically ill, ward), and route of delivery (oral, enteral and parenteral).

In the pre-operative population, a recent meta-analysis compared outcomes of IN vs. standard oral nutritional supplements (ONS) or a regular diet without supplements. IN showed no advantage compared to ONS in reducing wound infections, total infectious complications or non-infectious complications. Compared to standard diet, IN did not improve wound infections.[254]

A recent multi-center double-blinded randomized trial examined whether IN, given within 48 hours of ICU admission, reduced the incidence of infections compared with standard high-protein enteral nutrition in mechanically ventilated critically ill patients. There was no difference in post-op infectious complications between the two groups. Importantly, IN may have been harmful with slightly higher six-month mortality.[256]

In a Cochrane review published looking at pre-operative nutrition support in patients undergoing major gastro-intestinal surgery, IN seemed to be beneficial compared to control on reducing infectious complications in well-nourished patients. Yet, several limitations to the studies warrant carful interpretation, as most studies excluded patients who were at high risk of post-operative complications. It is also unknown if these studies were carried out in hospitals implementing advances in surgical care such as ERAS.[257]

In view of recent data, routine use of IN in surgical patients cannot be recommended, even though the 2009 guidelines from the American Society for Parenteral and Enteral Nutrition and the Society of Critical Care Medicine recommend the use of IN for surgical patients.[235]

Early Post-Operative Feeding

In traditional surgical care, it is common to start an oral diet in the post-operative phase once there is evidence of bowel activity. Such practice, amongst other elements of surgical and anesthesia care, was challenged by a group of European surgeons in order to improve outcome after major surgery under a multimodal perioperative care program, coined ERAS. The goal of the ERAS protocols, which include early post-operative feeding, is to remove obstacles that hinder the return to normal function (eating and drinking, bowel movements, ambulation and pain management) by modulating fluid balance, nausea, vomiting, gastric and intestinal motility, and decreasing metabolic stress and insulin resistance.[258]

Early post-operative feeding has been part of ERAS protocols for colorectal surgery,[246] cystectomy,[251] pancreaticoduodenectomy,[249] gastrectomy,[250] rectal and pelvic surgeries[252] and gynecological surgeries.[247]

Early post-operative feeding if often considered as allowing the patient to drink fluids after recovery from anaesthesia and then resuming normal hospital food within the first 24 hours after surgery. By doing so, patients can consume up to 1200-1500 kcal/d. This has been shown to be safe,[246] especially with concurrent aggressive antiemetic therapy.[247] Early use of oral or enteral feeding vs NPO has been shown to reduce risks of infections and length of stay without increased risk of anastomotic leaks.[246]

Measures to minimize bowel disturbance, such as maintaining fluid balance, avoidance of opioid, use of epidural anaesthetics must be considered in order to maximize nutritional intake.[259]

In patients who require postoperative artificial nutrition, enteral feeding or a combination of enteral and supplementary parenteral feeding is the first choice.

Postoperative parenteral nutrition[237] is beneficial in undernourished patients in whom enteral nutrition is not feasible or not tolerated. Postoperative parenteral nutrition is beneficial in patients with postoperative complications impairing gastrointestinal function that are unable to receive and absorb adequate amounts of oral/enteral feeding for at least seven days. In patients with prolonged gastrointestinal failure parenteral nutrition is life-saving.

OR Environment and SSI

There are numerous environmental factors in the operating room that can increase the risk of acquiring an SSI. These factors include, but are not limited to: the OR traffic pattern,[177-184] number of times the OR door opens,[177-184] OR ventilation characteristics,[177-179, 182-184] environmental cleaning surfaces,[177-183] and sterilization of the surgical equipment.[177-179, 181-183] A study by Young and O'Regan demonstrated a positive correlation between length of cases and frequency of door opening.[183] The average number of door swings range from 37 to 56 per hour and this can potentially disrupt the airflow and increases the risk of acquiring air borne wound contamination. Furthermore, the number of staff in the OR has a direct effect on the increased rate of door openings and equipment contamination.[185]

An appropriate air ventilation system may also play an important role in reducing infection rates. A study by Simsek Yavuz et al (2006) on surgical patients undergoing a sternotomy resulted in a 63 per cent reduction in SSI by equipping the operating rooms with laminar flow ventilation along with a disinfected environment and limited number of door openings.[184] However, there is also evidence that shows no significant reduction in SSI with the use of laminar flow ventilation.[186] Finally, the American Institute of Architects (AIA) requires a relative humidity of 30 to 60 per cent for an OR environment. There is no hard evidence that a statistically significant reduction in SSI rates can be demonstrated if these humidity levels are maintained. However, it is recommended to maintain the relative humidity of < 60 per cent in an Operating Room and record it in a logbook for future references.[187]

Recommendations to control infection in the OR environment based on the literature available:

- Reduce the number of times the doors open[177-183]
- The number of OR staff should be limited[177-183]
- The doors should close properly[177-183]
- Practice appropriate hand hygiene[177, 182]
- Appropriate sterilization of the equipment[177-183]
- Use of laminar flow ventilation[177-179, 184]

Post-Discharge SSI Surveillance

Significant morbidity is associated with surgical site infection. The majority of surgical site infections are detected after patients are discharged from hospital and consequently, may not be captured by hospital SSI surveillance.[188, 191] A recent study conducted by Bryce et al (2013) demonstrated that 86 per cent of patients with SSI were identified after the 30-day surveillance period, 93 per cent by three months, 97 per cent by six months, and 99 per cent by nine months.[189] National Healthcare Safety Network (NHSN) (2014) recommends that an SSI surveillance period should be at least 30 days for all superficial incisional SSIs and many of the deep incisional and organ/space SSIs.[229] The National Surgical Quality Improvement Project (NSQIP) also employs a 30 days surveillance period to document SSI outcomes.[190] There are some surgical procedures like cardiac and hip/knee arthoplasties that require a 90 day post-operative surveillance period. This list of surgical procedures can be found at: http://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf

Higher SSI rates at 30-days post-operatively were also found by the Health Quality Council of Alberta (HQCA). HQCA developed a tool linking electronic medical databases to retrieve SSI information from multiple electronic health records (surgery hospital records, inpatient records, physician billings, outpatient and emergency department visits). Upon review of all Alberta billing data, HQCA found that between April 2002 and September 2007, the SSI rate estimates at 30 days ranged from 1.7 times higher (hip replacement and cardiac valve procedures) to 5.2 times higher (C-sections) than those rates calculated based on hospital admission and readmission data.

Improvement for SSI Prevention Compliance

SSIs can significantly increase costs, morbidity and mortality among surgical patients. However, many of these infections can be prevented with increased adherence to the previously identified prevention strategies.[194] In a study by Hedrick et al., there was a decrease in the SSI rate in colorectal surgery patients from 25.6 per cent to 15.9 per cent due to a significant increase in compliance of the prevention guidelines.[195] In another study, increased compliance with the published guidelines resulted in almost a 40 per cent decrease in SSI rates, from 38 per cent to 92 per cent.[196] Unfortunately, lack of adherence with these strategies has been reported throughout Canada. A study based in the University of Toronto teaching hospitals stated that 75 to 90 per cent of respondents believed that following the published infection prevention guidelines was important; however, less than 50 per cent reported that these strategies were practiced consistently at their organizations.[197]

For instance, basic strategies to engage staff and increase compliance with process measures are proposed:

- Education sessions for the pre-admission and the surgical staff, physicians, patients and family members

- Create frontline ownership. Challenge frontline multidisciplinary teams (entire surgical staff and OR team) to identify areas of focus and local solutions to implement
- Inclusion of the entire surgical staff and OR team in the development of protocols, goals and incentives
- Campaign (posters, screensavers, videos, **SSI month** etc.) around focused prevention strategies to increase awareness
- Implement policies to standardize strategies
- Submit quarterly reports of compliance rates for each individual major process to management and frontline staff
- Quarterly SSI audit and feedback to management and frontline staff
- Develop a Frequently Asked Question brochure and make it available to everyone
- Form improvement teams that use one or more methodologies (improvement model, positive deviance, comprehensive unit-based safety program, or LEAN)
- Create pre-order sets and checklists
- Culture, teamwork and communication are very closely connected to teams effectively providing care for patients. Understanding your culture can be assessed through: surveys, observations or incident reporting systems[198] (including near misses)

National Context

Accreditation Canada plays a key role in urging healthcare organizations to follow evidence based practice. We have outlined below a summary of how Accreditation Canada is consistent with *Safer Healthcare Now!* definitions. Also, across the country, provincial ministries are playing larger roles in patient safety with setting mandatory requirements for their healthcare organizations. The Ontario Ministry of Health and Long Term Care has instituted mandatory reporting around clinical outcomes such as SSI. Other provinces in the country are following suit.

Accreditation Canada

Accreditation Canada has performance measures in place for surgical site infections (2008). These measures focus on the rate of post-surgical infections and the rate of timely administration of prophylactic antibiotics. The protocol attached to these measures allows an organization to select a surgical procedure that has the highest risk, highest surgical volume, or both.

Accreditation Canada recommends the following selected procedures to be included:

- cardiac surgery
- colorectal surgery
- hysterectomy
- C-section
- total joint arthroplasty
- craniotomy
- CSF shunts
- spinal surgery

Accreditation Canada recommends that the indicators of post-op infection rates and timing of prophylaxis be applied to the same surgical procedure, but it is not a necessity.

The practice of collecting both post-operative surgical infection and timing of prophylaxis is synonymous with the *Safer Healthcare Now*! data collection measures. Accreditation Canada specifies for each organization to establish their own post-operative surveillance time period. *Safer Healthcare Now!* recommends a 30-day post-operative time period.

Ontario - Ministry of Health and Long Term Care

The Ministry of Health and Long Term Care of Ontario (MOHLTC) has instituted mandatory reporting of patient safety indicators, some of which are aligned with *Safer Healthcare Now!* measures.

The MOHLTC indictor refers to timely prophylactic antibiotic use to help prevent surgical site infections in hip and knee joint replacement surgeries. SSI data is to be reported for all primary total, partial and hemi hip and knee joint replacements (not joint revisions) by all hospitals performing these surgeries. Time for antibiotic administration will be measured from the antibiotic infusion start time to the skin incision start time. The goal is to have the antibiotic completely infused within 60 minutes of the skin incision for antibiotics (such as clindamycin or cefazolin). When vancomycin is used, the start time is extended to 0 to 120 minutes prior to skin incision.

The MOHLTC indicator for SSI (antibiotic timing) and the *Safer Healthcare Now!* measure for antibiotic timing are identical. *Safer Healthcare Now!* does not limit the population for this measure to hips and knees, but recommends reporting data separately for each population for which data are being submitted.

Measurement

Safer Healthcare Now! recommends that baseline data be obtained before you begin implementing changes, to give your team and organization a picture of where you are starting from. If you are unable to obtain baseline data, your team may decide to conduct a retrospective chart review, or use other sources, to establish baseline data. We recommend you collect baseline data for those select surgical procedures you have chosen to work on. We suggest that you take a "snapshot" of three months or more, or whatever is feasible for your organization. Please refer to the sampling suggestion in each of the Technical Descriptions (**Appendix C**). However, you may find that you are unable to find the information you need in the patient records or through other sources. In this case you could engage in *real time* (concurrent) sampling to establish a baseline.

Appendix C contains further details on the technical descriptions of these measures, including definitions of terms, numerators, denominators, exclusions, and collection/sampling strategies.

Appendix C also contains a worksheet for each measure. The worksheets provide step-by-step tables for calculating the numerator, denominator, and final calculation for each measure.

The worksheets are tools to help measure the progress over time and are to be used following the baseline stage (before you have started to implement the bundles), early implementation and full implementation stages. It may be appropriate to collect some or all measures retrospectively, through chart review, but ideally your data will be collected concurrently.

Collection Strategy

Depending on your facility, the process measures (e.g. timely prophylactic antibiotic administration) usually requires new data collection. For some of the process measures it is possible to use data from the Discharge Abstract Database to identify the total number of selected surgical procedures (assuming that these are specified) and to exclude burns and transplant patients. Conceptually, it would be possible to report the percentage of these with post-op wound infections, presuming that recent coding education sessions have ensured appropriate coding of SSI.

Some of the outcome measures can be derived from CIHI data. Please explore this possibility in your organization, as it would reduce data collection time.

Given the complexity of reducing the incidence of surgical site infections, *Safer Healthcare Now!* offers the following tips and suggestions:

- If a region or organization has the resources, SSI rates should be risk adjusted (implying that risk variables be measured on all cases of a procedure whether infection occurs or not). However, we recognize that this is not possible for all organizations.
- *Safer Healthcare Now!* considers SSI rates collected for clean and clean-contaminated (NHSN wound class one and two) a form of risk adjustment. *Safer Healthcare Now!* is not mandating risk adjustment using ASA scores, length of surgery or co-morbidities (or other elements of further risk adjustment). Risk adjustment practices vary across organizations; and as a result make comparison of SSI rates between organizations inaccurate. *Safer Healthcare Now!* does accept all levels of risk adjusted data; but will not use it for comparative purposes. The key to measuring improvement with SSI rates is to measure rates consistently over time and use your own data for internal benchmarking purposes.
- SSI rates need to be monitored on a long-term basis to demonstrate trends. A normal variation may be noted in SSI rates even though prophylaxis compliance increases consistently.
- You will likely not see a reduction in SSI rates over a short period of time; we encourage teams to focus their change and interventions to improve the process measures of this SSI bundle.
- How consistently best practices are applied for each surgical case will directly influence SSI rates. For example: if proper hair removal occurs 10 per cent of the time

vs. 90 per cent of the time; over time this should affect your SSI rate. The application of the entire bundle 90 per cent of the time is more likely to reduce SSI rates.

- There are other variables, beyond the care components presented, which may affect SSI rates, such as: OR staff scrubbing technique, OR doors opening/closing, air quality, nutrition, perioperative hyperoxia, and surgical technique.
- The Institute of Healthcare Improvement (IHI) recent experience with their SSI collaborative has shown that measuring the number of cases between infections (vs. percentiles) has proven easier (with the goal to double the number of cases between an infection).
- Work closely with your infection control staff on this outcome measure of reducing SSIs to capitalize on their expertise and data sources.

Surveillance for SSI rates – 30 days

For the purpose of *Safer Healthcare Now!* measurement, we recommend tracking infections in patients up to 30 days post-operatively. The challenge of determining a surgical site infection is great. Most infections become apparent after discharge from hospital and most people with infections are not readmitted to the hospital where the surgery took place. The sensitivity of reporting from physicians and patients is low. Unless you have resources devoted to the follow up of each patient, infection rates, as determined by standard surveillance, will invariably be an underestimation of the actual rate. If you have no current processes in place for identifying infections for the 30 day surveillance period, *Safer Healthcare Now!* recommends you continue with the surveillance your facility regularly follows on a consistent basis.

Strategies that an organization may pursue if there are limited resources for surveillance are:

- Performing one–month follow up with the GP's and surgeons of discharged patients.
- Follow those patients who return to the hospital where the initial surgery was performed
- Track "in-hospital" infections only
- Add to discharge summary: "please contact my office (surgeon's) if the patient presents with an infection" (this may capture the superficial infections that present in the GP offices)
- Conducting 30 day follow up surveys/telephone contact for probable infections (not ideal – resource consuming and subjective in nature)
- There may be other databases that collect surgical site infection information that can be used as a proxy measure. This was done by the Health Quality Council of Alberta where they looked at physician billing data from multiple sources.

Run Charts

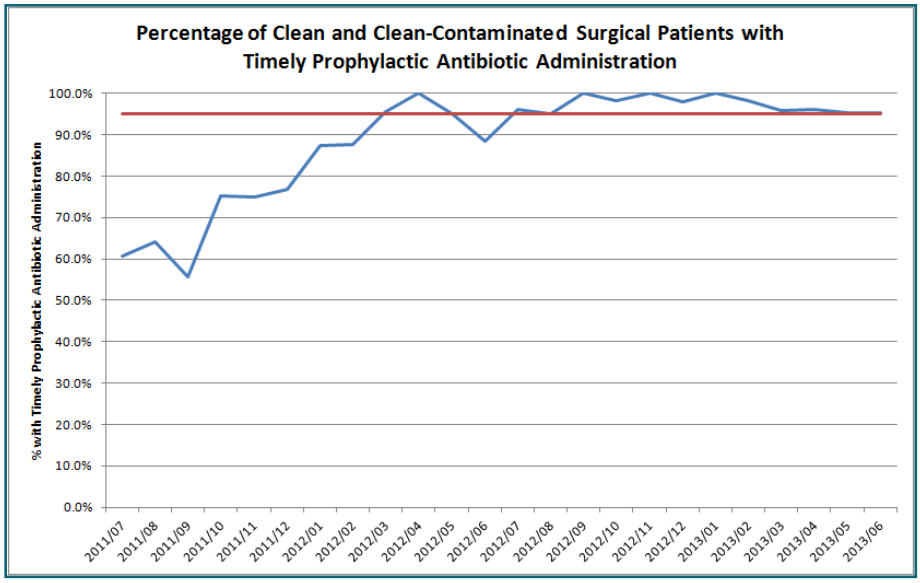
Improvement takes place over time. To determine if improvement has really been achieved and whether it is lasting requires observing patterns over time. Run charts are graphs of data

over time and are one of the single most important tools in performance improvement (sample charts attached to Technical Description 1.0 in **Appendix C**).

Using run charts has a variety of benefits:

- They help improvement teams formulate aims by depicting how well (or how poorly) a process is performing.
- They help in determining when changes are truly improvements by displaying a pattern of data that you can observe as you make changes.
- As you work on improvement, they provide information about the value of particular changes.

On-time Prophylactic Antibiotic Administration



First Test of Change

Teams may elect to work on any or all of the four care components: antimicrobial coverage, hair removal, perioperative glucose control, and perioperative normothermia. A first test of change should involve a very small sample size (typically one patient) and should be described ahead of time in a Plan-Do-Study-Act format so that the team can easily predict what they think will happen, observe the results, learn from them, and continue to the next test.

Example: Appropriate hair removal. The team decides to test removing razors from one operating room for one surgical procedure. They identify a surgeon who supports not using razors, and lets the surgeon know that the razors will be removed. On their PDSA form, they predict the surgeon will cope well without razors in the room. They then conduct the test. They note that the surgeon becomes frustrated because s/he wishes to use clippers to remove hair and there are no working clippers available. The team's study of the data indicates that they should repeat this test, after first making sure there is a set of operable clippers available.

Ideally, teams will conduct multiple small tests of change simultaneously across all four components of care. This simultaneous testing usually begins after the first few tests are completed and the team feels comfortable and confident in the process.

Implementation and Spread

For surgical site infection, teams will usually choose to begin their improvement process by working with a "pilot" population. This pilot population may be the hip- and knee-replacement patients, for example, or cardiac patients, or gynecologic patients, etc. It is possible to include all surgical patients in the pilot population, if that number is small (fewer than 20 cases per month). We recommend including at least 20 cases per month in the pilot population in order to increase the ability to measure and detect improvement.

In order to maximize the potential to reduce overall patient mortality related to surgical site infections, hospitals must share improvement strategies that start in a pilot population to all surgical populations. Organizations that successfully share improvements use an organized, structured method in planning and implementing spread across populations, units, or facilities. You can find information about planning, tracking, and optimizing spread at www.ihi.org.

Overcoming Barriers

Teams working on preventing surgical site infection have learned a great deal about barriers to improvement and how to address them. Some common challenges and solutions are:

- **Lack of support by leadership**
  Solution: Use opinion leaders (physicians) and data. If possible, a business case for the project may help to win leadership support.
- **Uneven physician acceptance of new practices**
  Solution: Use physician opinion leaders, review the medical literature, and feedback data on a surgeon-specific level. Remember that physicians may fall anywhere on the "Adoption of Innovations" curve. Work first with your early adopters and use their stories to convince the majority.

  The Adoption of Innovations curve is a model that classifies adopters of innovations based on their level of readiness to accept new ideas. Innovative adoption characteristics are assigned to groups to show that all innovations go through a predictable process before becoming widely adopted. The groups consist of early adopters, early majority, late majority and laggards.[230]

Appendices

Appendix A: Summary of *Safer Healthcare Now!* Recommendations

SSI Prevention Bundle Items	*Safer Healthcare Now!* Faculty Recommendation
Surgical Prophylactic Antibiotics including Caesarean-Section	Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that prophylactic antibiotic administration be started and completed within 60 minutes of first incision for caesarean sections.
Prophylactic Antibiotics with Tourniquet Use	Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that a prophylactic antibiotic infusion be started and completed within 60 minutes for most antibiotics or infused over 120 minutes for vancomycin and fluoroquinolones prior to application of tourniquet to maximize antibiotic efficacy.
Prophylactic Antibiotic Re-dosing and Duration	Based on the evidence, the *Safer Healthcare Now!* Faculty recommend that administration of prophylactic antibiotics be repeated for surgeries lasting longer than two half-lives of the antibiotic (e.g. four hours for cefazolin), or with blood loss greater than 1.5L. Antibiotics administered for cardiac, thoracic, orthopaedic and vascular patients should be discontinued within 24 hours of the end of surgery, whereas non-complex and uncomplicated surgeries require no further administration of antibiotics following surgery.
Surgical Antiseptic Skin Preparation	Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommends that the skin should be cleansed (shower or partial body wash) before surgery with either soap or an antiseptic agent at least the night before the operative day. The antiseptic of choice for surgical skin preparation should be alcohol-based chlorhexidine antiseptic solutions instead of povidone-iodine, unless contraindicated. Following application of chlorhexidine-alcohol skin preparation solution, surgical teams should complete the briefing element of the surgical checklist to allow several minutes for the skin antiseptic to dry prior to first incision. To maximize efficacy, CHG-alcohol skin antiseptic that will be covered by the surgical dressing should not be washed off at the end of surgical procedure.

SSI Prevention Bundle Items	*Safer Healthcare Now!* Faculty Recommendation
	In order to reduce the risk of fire, It is imperative that any alcohol-based skin antiseptic be allowed to air dry for at least three minutes or longer if there is excessive hair insitu. Non-alcoholic solutions should be used as a skin preparation in emergent cases when there is not enough time to allow alcohol solution to completely dry before incision. Chlorhexidine-alcohol solutions must *not* be used for procedures involving the ear, eye, mouth, mucous membranes, neural tissue, non-intact skin or open wounds.
Hair Removal	Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommends that patients be educated not to shave in the vicinity of the incision for one week pre-operatively. Optimally, no hair should be removed prior to surgery. If hair removal is necessary, clippers should be used preferably outside of the OR and within two hours of surgery. Do not use razors in the vicinity of the surgical site. Patients should shower after clipping due to the increased risk of bacterial contamination of the surgical site from hair.
Perioperative Glucose Control	Based on the evidence, The *Safer Healthcare Now!* SSI Faculty recommends that perioperative blood glucose levels be checked on all surgical patients who are diabetic or have risk factors for diabetes. Teams are encouraged to apply glucose control (<10-11 mmol/L) to surgical populations as directed by your local organization. Strict blood glucose levels (<6.1 mmol/L) should be avoided.
Perioperative Normothermia	Based on the evidence, the *Safer Healthcare Now!* SSI Faculty recommend that measures be taken to ensure that the core temperature of surgical patients remains between 36.0^0C and 38.0^0C pre-operatively, intra-operatively, and while in PACU. Pre-warming and intra-operative warming are indicated for all surgeries scheduled to last 30 minutes or more. Fluid warmers should be used if the surgical procedure is planned to last more than one hour. The ambient room temperature in the OR should be between 20-23°C.

Appendix B: Plan-Do-Study-Act Cycle

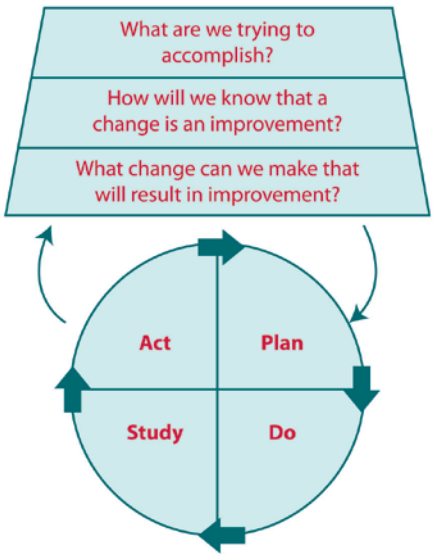
Using the Model for Improvement to Accelerate Change

The **Model for Improvement**, developed by Associates in Process Improvement, is a simple yet effective tool not meant to replace change models that organizations may already be using, but rather to accelerate improvement. This model has been used very successfully by hundreds of healthcare organizations in many countries to improve many different healthcare processes and outcomes.

The Improvement Model has two parts:

- Three fundamental questions, which can be addressed in any order.
    1. What are we trying to accomplish?
    2. How will we know that a change is an improvement?
    3. What changes can we make that will result in improvement?

- The Plan-Do-Act-Study (PDSA) cycle to test and implement changes in real work settings. The PDSA cycle guides the test of a change to determine if the change is an improvement.



Langley, G., Moen, R., Nolan, K., Nolan, T., Norman, C. & Provost, L. (2009). The Improvement Guide. A Practical Approach to Enhancing Organizational Performance. 2nd Edition. San Francisco: John Wiley & Sons, Inc. This material is reproduced with permission of John Wiley & Sons, Inc.

Set Aims

Improvement requires setting aims. The aim should be time specific and measurable; it should also define the specific population of patients that will be affected.

Establish Measures

Teams use quantitative measures to determine if a specific change actually leads to an improvement.

Select Changes

All improvement requires making changes, but not all changes result in improvement. Organizations therefore must identify the changes that are most likely to result in improvement.

Test Changes

The Plan-Do-Study-Act (PDSA) cycle is shorthand for testing a change in the real work setting — by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method used for action-oriented learning.

Steps in the PDSA Cycle

Step 1: Plan

Plan the test or observation, including a plan for collecting data.

- State the objective of the test.
- Make predictions about what will happen and why.
- Develop a plan to test the change (Who? What? When? Where? What data need to be collected?).

Step 2: Do

Try out the test on a small scale.

- Carry out the test.
- Document problems and unexpected observations.
- Begin analysis of the data.

Step 3: Study

Set aside time to analyze the data and study the results.

- Complete the analysis of the data.
- Compare the data to your predictions.
- Summarize and reflect on what was learned.

Step 4: Act

Refine the change, based on what was learned from the test.

- Determine what modifications should be made.
- Prepare a plan for the next test.

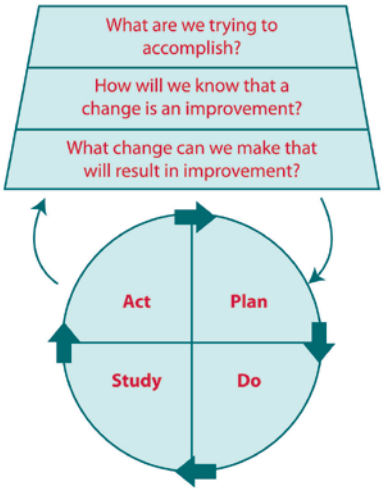
Teams may elect to work on any or all of the four care components: antimicrobial coverage, hair removal, perioperative glucose control, and perioperative normothermia. A first test of change should involve a very small sample size (typically one patient) and should be described ahead of time in a Plan-Do-Study-Act format so that the team can easily predict what they think will happen, observe the results, learn from them, and continue to the next test.

Example: Appropriate hair removal

The team decides to test removing razors from one operating room for one surgery. They identify a surgeon who supports the avoidance of razors, and let the surgeon know that the razors will be removed. On their PDSA form, they predict that the surgeon will cope well without razors in the room. They then conduct the test. They note that the surgeon wants to use clippers to remove hair and becomes frustrated because there are no working clippers in the room. The team's study of the data indicates that they should repeat this test, after first making sure there is a set of operable clippers available in the operating room.

Ideally, teams will conduct multiple small tests of change simultaneously across all four components of care. This simultaneous testing usually begins after the first few tests are completed and the team feels comfortable and confident in the process.

A. Set Aims (Goals and Objectives)



Improvement requires setting aims. An organization will not improve without a clear and firm intention to do so. The aim should be time specific and measurable; it should also define the specific population of patients that will be affected. Agreeing on the aim is crucial; so is allocating the people and resources necessary to accomplish the aim.

Setting an aim can assist teams to focus on what they are hoping to achieve when implementing SSI prevention strategies.

The following examples are aims at the organizational level:

1. Improve compliance with prophylactic antibioitic timing for surgical patients to 100 per cent by June 2015.
2. Improve implementation of all four surgical site infection prevention bundle items in the department of X surgery from 50 per cent to 90 per cent by December 2015.

As teams work on different ideas, the aims should be specific to what it is they are hoping to achieve at that point.

B. Establish Measures

Measurement is a critical part of testing and implementing changes; measures tell a team whether the changes they are making actually lead to improvement. Measurement for improvement should not be confused with measurement for research. This difference is outlined in the chart below:

	Measurement for Research	Measurement for Learning and Process Improvement
Objective	To discover new knowledge	To bring new knowledge into daily practice
Tests	One large "blind" test	Many sequential, observable tests
Biases	Control for as many biases as possible	Stabilize the biases from test to test
Data	Gather as much data as possible, "just in case"	Gather "just enough" data to learn and complete another cycle
Duration	Can take long periods of time to obtain results	"Small tests of significant changes" accelerates the rate of improvement

Three Types of Measures

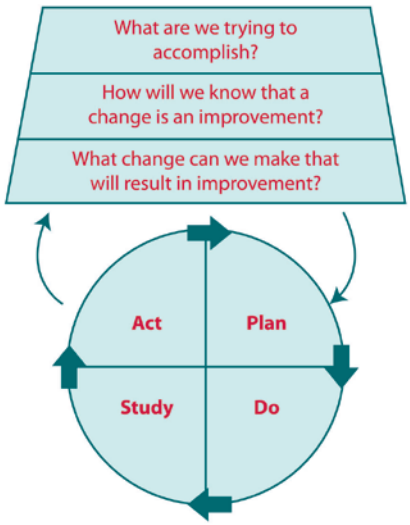
Use a balanced set of measures for all improvement efforts:

1. **Outcome Measures**
   How is the system performing? What is the result?
2. **Process Measures**
   Are the parts/steps in the system performing as planned?
3. **Balancing Measures**
   Are changes designed to improve one part of the system causing new problems in other parts of the system? This measure often addresses staff satisfaction and workload issues.

Measuring for improvement starts with collecting baseline data to determine the seriousness of the problem to help motivate stakeholders. Then, collect data regularly to track the effectiveness of change over time.

C. Select Changes

While all changes do not lead to improvement, all improvement requires change. The ability to develop, test, and implement changes is essential for any individual, group, or organization that wants to continuously improve. There are many kinds of changes that will lead to improvement, but these specific changes are developed from a limited number of change concepts.



A change concept is a general notion or approach to change that has been found to be useful in developing specific ideas for changes that lead to improvement. Creatively combining these change concepts with knowledge about specific subjects can help generate ideas for tests of change. After generating ideas, run Plan-Do-Study-Act (PDSA) cycles to test a change or group of changes on a small scale to see if they result in improvement. If they do, expand the tests and gradually incorporate larger and larger samples until you are confident that the changes should be adopted more widely.

D. Test Changes

Once a team has set an aim, established its membership, and developed measures to determine whether a change leads to an improvement, the next step is to test a change in the real work setting. The Plan-Do-Study-Act (PDSA) cycle is shorthand for testing a change — by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method used for action-oriented learning.

Reasons to Test Changes

- To increase your belief that the change will result in improvement.
- To decide which of several proposed changes will lead to the desired improvement.
- To evaluate how much improvement can be expected from the change.
- To decide whether the proposed change will work in the actual environment of interest.
- To decide which combinations of changes will have the desired effects on the important measures of quality.
- To evaluate costs, social impact, and side effects from a proposed change.
- To minimize resistance upon implementation.

Implement Changes

After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale — for example, for a pilot population or on an entire unit. This pilot population may be the hip- and knee-replacement patients, for example, or cardiac operations, or gynaecologic procedures, etc. It is possible to include the universe of surgical patients in the pilot population, if that number is small (fewer than 20 cases per month). We recommend including at least 20 cases per month in the pilot population in order to increase the ability to measure and detect improvement.

Spread changes

Spread is the process of taking a successful implementation process from a pilot unit or pilot population and replicating that change or package of changes in other parts of the organization or other organizations. During implementation, teams learn valuable lessons necessary for successful spread, including key infrastructure issues, optimal sequencing of tasks, and working with people to help them adopt and adapt a change.

Spread efforts will benefit from the use of the PDSA cycle. Units adopting the change need to plan how best to adapt the change to their unit and to determine if the change resulted in the predicted improvement.

As experience develops and measurement of the success of your SSI strategies process reflects sustained improvement the process can be implemented for more patients in more areas. Evaluate at each new step before adding more units to the process. Retest the pilot process on new units in order to identify any revisions that may be needed. The roll-out across an organization requires careful planning to move through each of the major implementation phases.

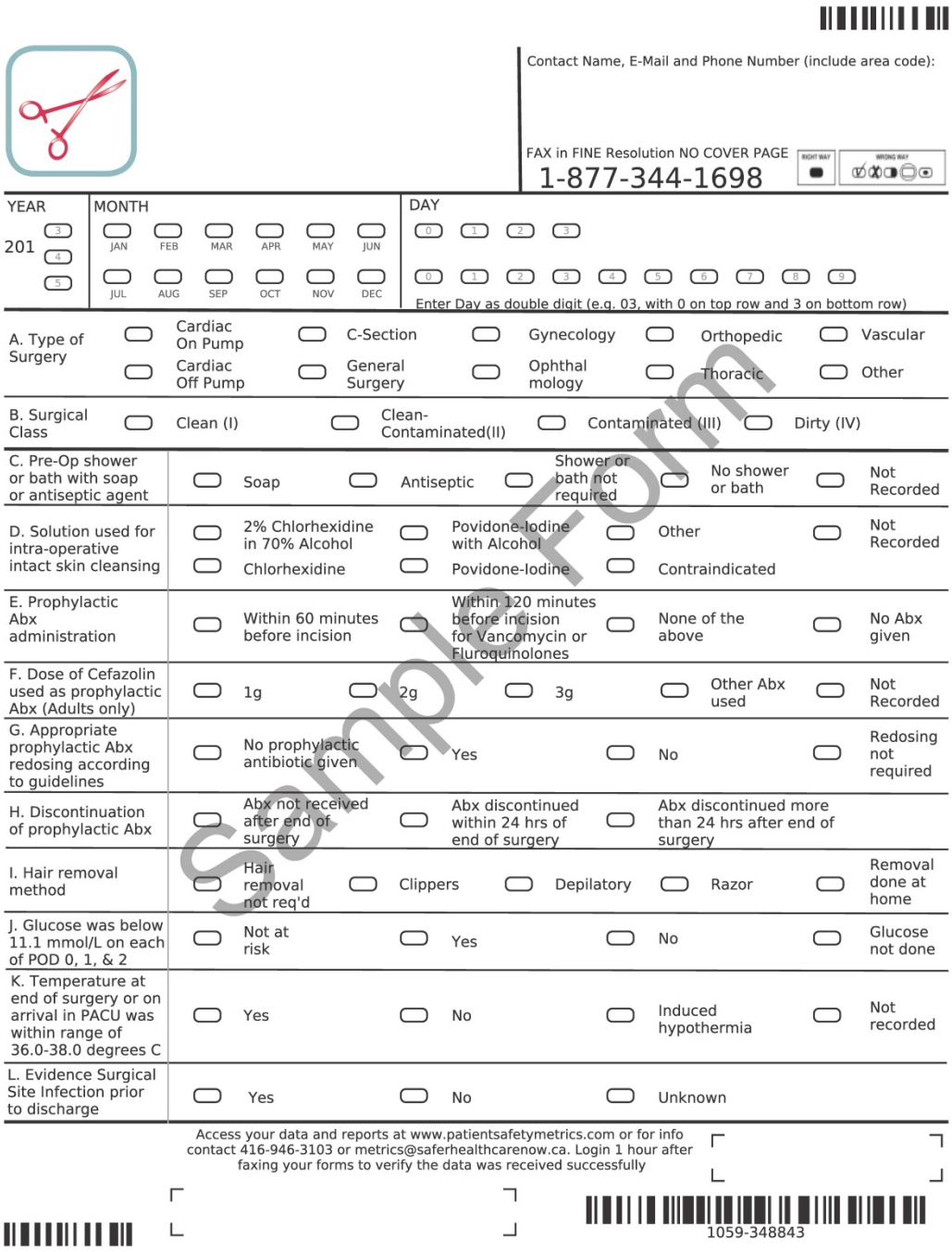
A key factor for closing the gap between best practice and common practice is the ability of healthcare providers and their organizations. The IHI's 'A Framework of Spread: From Local Improvements to System-Wide Change' will assist teams to develop, test and implement a

system for accelerating improvement by spreading change ideas within and between organizations. This paper will assist teams to "prepare for a spread; establish an aim for spread; and develop, execute, and refine a spread plan." Some issues to address in planning for spread include training and new skill development, supporting people in new behaviours that reinforce the new practices, problem solving, current culture regarding change, degree of buy-in by staff, and assignment of responsibility.

Further information on sustaining and spreading improvements can be accessed by using the following link:
www.ihi.org/IHI/Results/WhitePapers/AFrameworkforSpreadWhitePaper.htm

Appendix C: Technical Descriptions and Data Screens

Data Collection Form and Flow Chart



Contact Name, E-Mail and Phone Number (include area code):

FAX in FINE Resolution NO COVER PAGE
1-877-344-1698

YEAR: 201 3 4 5

MONTH: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

DAY: 0 1 2 3 / 0 1 2 3 4 5 6 7 8 9
Enter Day as double digit (e.g. 03, with 0 on top row and 3 on bottom row)

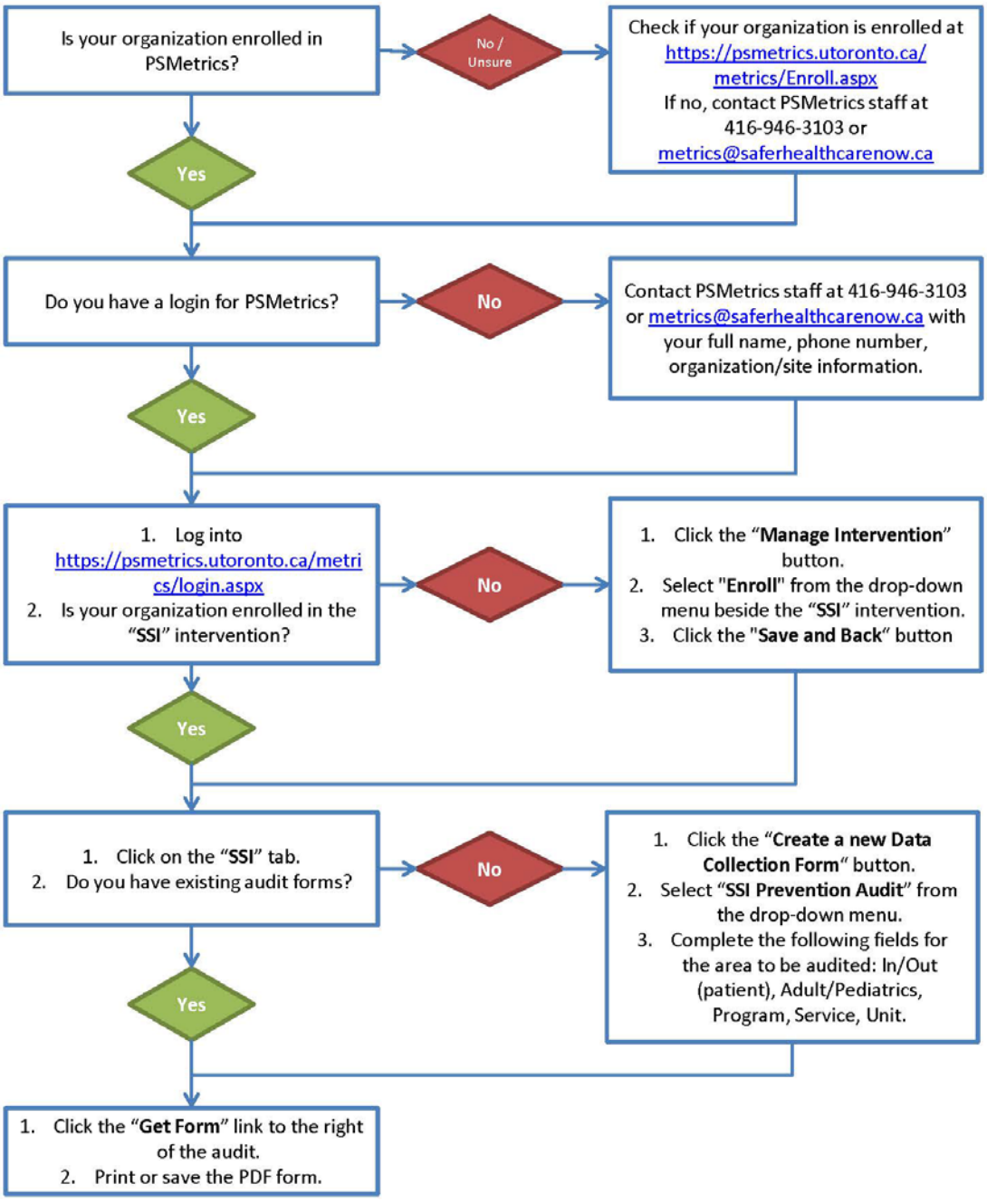
A. Type of Surgery	Cardiac On Pump	C-Section	Gynecology	Orthopedic	Vascular
	Cardiac Off Pump	General Surgery	Ophthal mology	Thoracic	Other
B. Surgical Class	Clean (I)	Clean-Contaminated(II)	Contaminated (III)	Dirty (IV)	
C. Pre-Op shower or bath with soap or antiseptic agent	Soap	Antiseptic	Shower or bath not required	No shower or bath	Not Recorded
D. Solution used for intra-operative intact skin cleansing	2% Chlorhexidine in 70% Alcohol	Povidone-Iodine with Alcohol	Other		Not Recorded
	Chlorhexidine	Povidone-Iodine	Contraindicated		
E. Prophylactic Abx administration	Within 60 minutes before incision	Within 120 minutes before incision for Vancomycin or Fluroquinolones	None of the above		No Abx given
F. Dose of Cefazolin used as prophylactic Abx (Adults only)	1g	2g	3g	Other Abx used	Not Recorded
G. Appropriate prophylactic Abx redosing according to guidelines	No prophylactic antibiotic given	Yes	No		Redosing not required
H. Discontinuation of prophylactic Abx	Abx not received after end of surgery	Abx discontinued within 24 hrs of end of surgery	Abx discontinued more than 24 hrs after end of surgery		
I. Hair removal method	Hair removal not req'd	Clippers	Depilatory	Razor	Removal done at home
J. Glucose was below 11.1 mmol/L on each of POD 0, 1, & 2	Not at risk	Yes	No		Glucose not done
K. Temperature at end of surgery or on arrival in PACU was within range of 36.0-38.0 degrees C	Yes	No	Induced hypothermia		Not recorded
L. Evidence Surgical Site Infection prior to discharge	Yes	No	Unknown		

Access your data and reports at www.patientsafetymetrics.com or for info contact 416-946-3103 or metrics@saferhealthcarenow.ca. Login 1 hour after faxing your forms to verify the data was received successfully

1059-348843

To submit the Data Collection Form to the Central Measurement Team, follow the steps in the flow diagram below, or contact metrics@saferhealthcarenow.ca for more information.

Flowchart: Steps to generate your SSI audit tool(s) in Patient Safety Metrics



Technical Description of the Measurement Worksheets

Implementation Stages – Definitions apply to all interventions and measures

Baseline Stage (Pre-intervention) - Data collected for Baseline should be collected prior to implementing small tests of change and reflect the current process.

Early (Partial) Implementation Stage - The team has set a clear aim(s) for the SSI intervention, identified which measures will indicate if the changes will lead to improvement, and started to implement small tests of change (PDSA) to identify and refine processes, procedures and practices which will lead to improvement and achieving the aim. When the team is close to goal they are ready to move to Full Implementation.

Full Implementation Stage (At Goal) - The processes, procedures and practices are finalized and have led to significant improvement. These practices on the selected unit are being consistently applied and monitored, showing a sustained performance at or close to goal. The team has achieved their aim(s) and is ready to spread to other areas.

1.0 Per cent of Clean and Clean-Contaminated Patients with Timely Prophylactic Antibiotic Administration: Sample Measurement Worksheet

SSI 1 - Percentage of Clean and Clean-Contaminated Patients with Timely Prophylactic Antibiotic Administration (In Patient, Adult)

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. The percentage of clean and clean-contaminated patients receiving timely prophylactic antibiotic administration delivered within 60 minutes prior to the surgical incision and ideally completely infused before tourniquet inflation during this reporting period. Vancomycin and fluoroquinolones should be infused over one to two hours therefore their administration should begin within 120 minutes prior to the first incision. The auditor should measure the timing of the antibiotic administration from antibiotic start time to surgical (incision) start time. If either time is missing, count as NOT obtaining prophylactic antibiotics on time.

1 Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.

2 Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.

3 Subtract the total number of patients with an existing infectious process at the same site as the planned surgical procedure on admission to hospital, and those with surgeries that are classified as class three or four (NHSN).

4 Subtract the total number of patients who were not given antibiotics at any time from arrival in hospital through first 24 hours post-operatively.

5 Enter the total number of patients included in this sample after exclusions.

Denominator

Detail worksheet (optional)

6 **Enter the total number of patients included in this sample after exclusions.** [ ]

Numerator

7 Identify the total number of patients in the denominator whose prophylactic antimicrobial was either vancomycin or fluorquinolones which was administered over 120 minutes and completed within 0 to 60 minutes prior to the first surgical incision time. [ ]

8 Identify the total number of patients in the denominator whose prophylactic antimicrobial was any antibiotic other than vancomycin or fluoroquinolones and administration was completed within 0 to 60 minutes prior to the first surgical incision time. [ ]

9 **Enter the total number of patients in this sample for whom timely prophylactic antibiotics were administered (#7 + #8).** [ ]

Your Result

10 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95% or higher

1.0 Per cent of Clean and Clean-Contaminated Surgical Patients with Timely Prophylactic Antibiotic Administration - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
The percentage of clean and clean-contaminated patients receiving timely prophylactic antibiotic administration delivered within 60 minutes prior to the surgical incision and ideally completely infused before tourniquet inflation during this reporting period. The prophylactic antibiotic infusion is to be started and completed within 60 minutes for most antibiotics or infused within 120 minutes for vancomycin and fluoroquinolones prior to skin incision or application of tourniquet. For C-sections, prophylactic antibiotics should be started and completed within 60 minutes prior to the first incision rather than after cord clamping. The auditor should measure the timing of the antibiotic administration from antibiotic start time to surgical (incision) start time. If either time is missing, count as NOT obtaining prophylactic antibiotics on time.

Standard Goal: 95% or higher

Note: Sustain the percentage of surgical patients with timely prophylactic antibiotic administration at 95% or higher

CALCULATION DETAILS:

Numerator Definition: Number of selected surgical patients whose prophylactic antibiotics were started and completed within 60 minutes prior to the first surgical incision

Note: Cases for which either vancomycin or a fluoroquinolone were used as prophylactic antimicrobial: These antibiotics need to be started and infused over 120 minutes (to avoid Red Man Syndrome). The infusion needs to be completed within 0 - 60 minutes before first surgical incision. Patients who receive these antibiotics up to 60 minutes before first incision will count in the numerator.

Numerator Exclusions:

- Same exclusions as for denominator
- No prophylactic antibiotics given
- Infusion of prophylactic antibiotics completed after the first incision or tourniquet inflation

Denominator Definition: Number of selected surgical patients for this reporting period sample, after exclusions

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form

The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form.

DCF Response Options – SSI 1 (*numerator)

- *within 60 minutes before incision
- *within 120 minutes before incision for Vancomycin or Fluoroquinolones
- None of the above
- No antibiotics given

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of Hip Arthroplasty pts. with antibiotic infusion started and completed within 60 minutes of incision --- Total no. of Clean and Clean-contaminated Hip Arthroplasty pts. (in a particular time frame)	**X 100 =**	*Per cent of* Clean and Clean-contaminated *Hip Arthroplasty Patients with Timely Prophylactic Antibiotic Administration*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.
- If more than one inpatient surgical procedure occurred during the index hospitalization, only the first surgical procedure should be considered for the purposes of this measure.
- The auditor should measure the timing of the antibiotic administration from antibiotic start time to surgical (incision) start time.
- For cases involving use of an inflatable cuff or tourniquet applied to the operative site, the antibiotic should be fully infused prior to inflation of the cuff.
- If you are using a surgical checklist in your OR, consider adding "Antibiotic Prophylaxis: fully infused?" to the Briefing section.

- If you have two prophylactic antibiotics you count the infusion time of the last prophylactic antibiotic administered.

Note: Patients for whom antibiotic start time or incision time is not recorded are counted as not obtaining prophylactic antibiotics on time (i.e., a zero in the numerator).

***Please Note:* The following information on collection strategy and sampling strategy and graphs pertains to all of the measurements contained within **Appendix C**.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

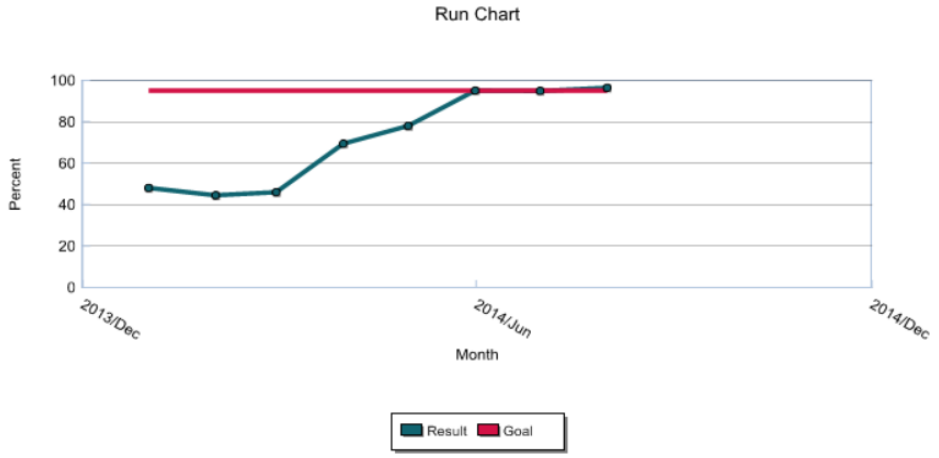
Sample Run Chart:

SSI 1 - Percent of Clean and Clean-Contaminated Patients with Timely Prophylactic Antibiotic Administration

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	55	53	96.36%	ABX when surgeon in OR
2014/Jul	58	55	94.83%	ABX given when Surgeon in OR
2014/Jun	60	57	95.00%	Anaesthetists giving ABX when surgeon enters OR
2014/May	59	46	77.97%	Anaesthetists agree to give ABX in OR
2014/Apr	62	43	69.35%	Test giving ABX in holding area once patient is transferred to OR
2014/Mar	37	17	45.95%	Still giving ABX on call from OR
2014/Feb	90	40	44.44%	
2014/Jan	100	48	48.00%	

2.0 Per cent of Clean and Clean-Contaminated Patients with Appropriate Prophylactic Antibiotic Discontinuation: Sample Measurement Worksheet

SSI 2 - Percentage of Clean and Clean-Contaminated Patients with Appropriate Prophylactic Antibiotic Discontinuation (In Patient, Adult)

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. The percentage of clean and clean-contaminated surgical patients whose prophylactic antibiotics were discontinued within 24 hours after surgery end time. Antibiotics administered for cardiac, thoracic, orthopedic and vascular patients should be discontinued within 24 hours of the end of surgery, whereas other surgeries require no further administration of prophylactic antibiotics following surgery. (SSI-GSK pg 21).

1	Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.	
2	Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.	
3	Subtract the total number of patients with an existing infectious process at the same site as the planned surgical procedure on admission to hospital, and those with surgeries that are classified as class three or four (NHSN).	
4	Subtract the total number of patients who were not given antibiotics at any time from arrival in hospital through first 24 hours post-operatively.	
5	Subtract the total number of patients whose antibiotics are not included in your organization's procedure-specific Antimicrobial Guidelines.	
6	Subtract the total number of patients who developed a postoperative infection within 48 hours following surgery.	
7	Enter the total number of patients included in this sample after exclusions.	
Denominator		
	Detail worksheet (optional)	
8	**Enter the total number of patients included in this sample after exclusions.**	
Numerator		
9	Indicate the number of patients with **ABX not received after end of surgery**.	
10	Indicate the number of patients with **ABX discontinued within 24 hours of end of surgery**.	
11	Indicate the number of patients with **ABX discontinued more than 24 hours after end of surgery**.	
12	**Enter the total number of patients whose prophylactic antibiotics were discontinued less than 24 hours (1440 minutes) after surgery end time.**	
Your Result		
13	Numerator/Denominator x 100 = %	Your Result [ ]
		Goal 95% or higher

2.0 Per cent of Clean and Clean-Contaminated Surgical Patients with Appropriate Prophylactic Antibiotic Discontinuation – Technical Description

Intervention: Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
The percentage of clean and clean-contaminated surgical patients whose prophylactic antibiotics were discontinued within 24 hours after surgery end time. Antibiotics administered for cardiac, thoracic, orthopedic and vascular patients should be discontinued within 24 hours of the end of surgery, whereas other surgeries require no further administration of prophylactic antibiotics following surgery. (See page 23: Single dose Antibiotic Prophylaxis)

Standard Goal: 95% or higher

Note: Sustain the percentage of surgical patients with appropriate prophylactic antibiotic discontinuation at 95% or higher

CALCULATION DETAILS:

Numerator Definition: Number of selected clean and clean-contaminated surgical patients whose prophylactic antibiotics were discontinued within 24 hours after surgery end time (e.g. for cefazolin up to three Q8h doses after surgery end time or for vancomycin, up to two Q12h doses after surgery end time).

Note: Single dose prophylaxis is optimal for most non-complex and uncomplicated surgeries (see page 23). For surgical patients who require 24 hours of antibiotics (cardiac, thoracic, orthopedic and vascular), the scheduled doses should start after the surgery has finished (e.g. if administering cefazolin, the first should be administered eight hours from the surgical end time and the remaining two doses administered every eight hours after that). *See definition of terms below for which surgeries are included for this measure.*

Numerator Exclusions:

- Same exclusions as for denominator
- Prophylactic antibiotics discontinued more than 24 hours after the end of surgery

Denominator Definition: Total number of patients included in this sample after exclusions

Denominator Exclusions:

- Existing infectious process at the same site as the surgical procedure or surgeries that are classified as wound class 3 or 4[€] (Contaminated and Dirty Infected - NHSN – **Appendix D**)
- Patients less than 18 years of age

[€] Please **see Appendix D** for NHSN definitions

- Patients who were not given antibiotics at any time from arrival to hospital through the first 24 hours post-operatively
- Patients who were diagnosed with and treated for infections within two days after surgery date that cannot be linked to the surgical procedure or an infection may have existed prior to surgery.

Compliance Bundle: The data collected for this indicator is available for the individual responses and presented as a Compliance Run Chart with the performance for each response category displayed separately. The data are also available in tabular format.

Bundle Elements include:

- Prophylactic Antibiotics not received after end of surgery
- Prophylactic Antibiotics discontinued within 24 hours of end of surgery
- Prophylactic Antibiotics discontinued more than 24 hours after end of surgery
- Prophylactic antibiotics discontinued less than 24 hours (1440 minutes) after surgery end time

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form:

DCF Response Options – SSI 2 (*numerator)

- *ABX not received after end of surgery
- *ABX discontinued within 24 hours of end of surgery
- ABX discontinued more than 24 hours after end of surgery
- ABX discontinued less than 24 hours (1440 minutes) after surgery end time

Measurement Period: Monthly

Definition of Terms:

Prophylactic antibiotics: The use of antibiotics before, during, or after a diagnostic, therapeutic, or surgical procedure to prevent infectious complications infection (i.e., not those being given therapeutically for treatment of active infections).[99]

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: No. of clean or clean-contaminated pts. with prophylactic antibiotics either not given or discontinued within 24 hours of the end of surgery --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated S*urgical patients with Appropriate Prophylactic Antibiotic Discontinuation*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

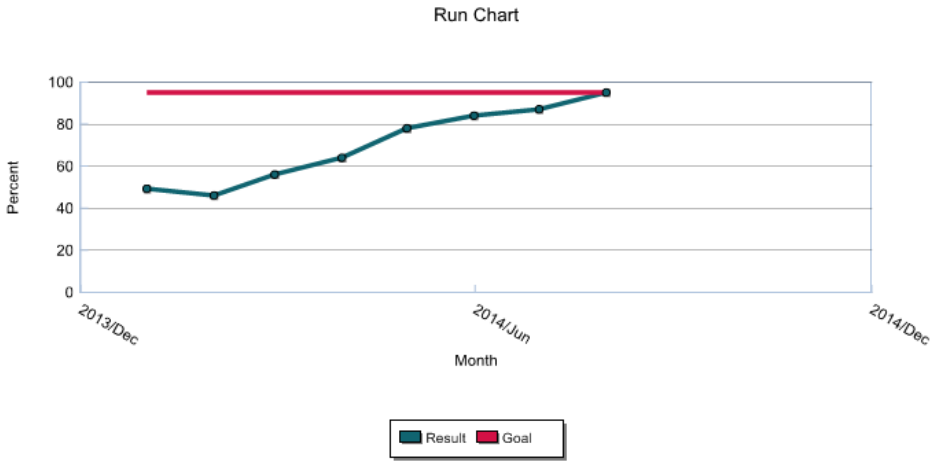
Sample Run Chart:

SSI 2 - Percent of Clean and Clean-Contaminated Patients with Appropriate Prophylactic Antibiotic Discontinuation

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	100	95	95.00%	
2014/Jul	100	87	87.00%	
2014/Jun	100	84	84.00%	
2014/May	100	78	78.00%	
2014/Apr	100	64	64.00%	
2014/Mar	100	56	56.00%	
2014/Feb	100	46	46.00%	
2014/Jan	65	32	49.23%	

3.0 Per cent of Clean and Clean Contaminated Surgery Patients with Surgical Infection: Sample Measurement Worksheet

SSI 3 - Percentage of Clean and Clean Contaminated Surgery Patients with Surgical Infection (In Patient, Adult)

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. Rate of infection within 30 days post-operatively in clean and clean-contaminated surgical patients and 31-90 days post-operatively for patients undergoing surgery involving an implant (e.g. hip or knee arthroplasty) and cardiac surgery.

1 Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.

2 Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.

3 Subtract the total number of patients with an existing infectious process at the same site as the planned surgical procedure on admission to hospital, and those with surgeries that are classified as class three or four (NHSN).

4 Enter the total number of patients included in this sample after exclusions.

Denominator

Detail worksheet (optional)

5 **Enter the total number of patients included in this sample after exclusions.** [ ]

Numerator

6 Indicate the number of patients in denominator who developed a post-operative wound infection/nosocomial infection **within 30 days** of the surgical procedure as defined in NNIS (see Appendix C). [ ]

7 Indicate the number of patients in denominator who developed a post-operative wound infection/nosocomial infection **within 31 to 90 days** of the surgical procedure as defined in NNIS (see Appendix C). [ ]

8 **Enter the total number of patients who developed a post-operative wound infection/nosocomial infection within 30 days and 31-90 days of the surgical procedure as defined in NNIS (see Appendix C).** [ ]

Your Result

9 Numerator/Denominator x 100 = % Your Result [ ]

Goal Goal may be set by individual organizations/teams however, IHI recommends a reduction of 50%

3.0 Per cent of Clean and Clean Contaminated Surgery Patients with Surgical Infection – Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
Percentage of infection within 30 days post-operatively in clean and clean-contaminated surgical patients and 31-90 days post-operatively for patients undergoing surgery involving an implant (e.g. hip or knee arthroplasty) and cardiac surgery

Standard Goal: Reduce baseline by 50%

Note: Reduce the Per cent of Surgical Patients with Surgical Infection by 10% every year

CALCULATION DETAILS:

Numerator Definition: The total number of patients in the denominator who developed a post-operative wound infection/nosocomial infection within 30 days and 31-90 days of the surgical procedure

Numerator Exclusions: Same exclusions as for denominator exclusions

Denominator Definition: Number of clean and clean-contaminated surgery patients after exclusions in this reporting period

Denominator Exclusions:

- Patients who are less than 18 years of age
- Patients who had a principal or admission diagnosis suggestive of pre-operative infectious diseases or surgeries that are classified as wound class 3 or 4 (see **Appendix D**)

Data Collection (Audit) Form

Given that this measure is collected a minimum of 30 to 90 days postoperatively it is not included as a question on the data collection form.

Measurement Period: Monthly

Definition of Terms:

- ***Class 1 – Clean surgery patient*:** A patient having had a surgery in which the wound is clean, by the NHSN definition: "Uninfected operative wounds in which no inflammation is encountered and 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 criteria."

- ***Class 2 - Clean / Contaminated Surgery patient*:** "An operative wound 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."
- ***Post-operative wound infection*:** A nosocomial infection of the operative site, as defined by National Healthcare Safety Network (NHSN) (see **Appendix D**).

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of clean or clean-contaminated pts. with prophylactic antibiotics either not given or discontinued within 24 hours of the end of surgery --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated S*urgical patients with Appropriate Prophylactic Antibiotic Discontinuation*

Comments :

Safer Healthcare Now! recommends:

- If a region or organization has the resources, SSI rates should be risk adjusted (implying that risk variables be measured on all cases of a procedure whether infection occurs or not). However, we recognize that this is not possible for all organizations.
- SSI rates need to be monitored on a long-term basis for assessment trends; you will note a pattern of normal variation even though prophylaxis compliance increases consistently.
- Work closely with your infection control department on this outcome measure.

Infection rates for clean and clean contaminated surgical procedures differ; therefore they should be calculated in separate groups and entered to data set separately.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

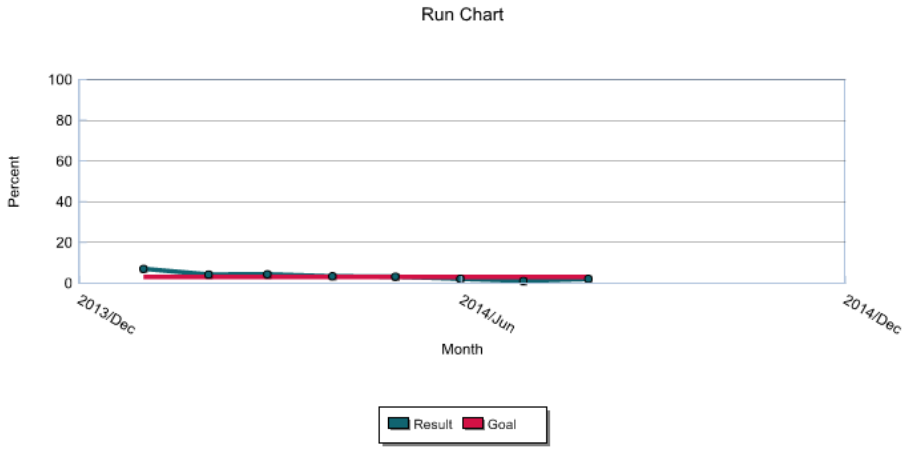
Sample Run Chart:

SSI 3 - Percent of Clean and Clean Contaminated Surgery Patients with Surgical Infection

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	100	2	2.00%	
2014/Jul	94	1	1.06%	
2014/Jun	96	2	2.08%	
2014/May	94	3	3.19%	OR Rounds on prophylactic abx - timing, redosing etc
2014/Apr	90	3	3.33%	OR rounds on redusing post-op infection
2014/Mar	92	4	4.35%	
2014/Feb	95	4	4.21%	
2014/Jan	100	7	7.00%	

4.0 Per cent of Surgical Patients with Appropriate Hair Removal: Sample Measurement Worksheet

SSI 4 - Percentage of Surgical Patients with Appropriate Hair Removal (In Patient, Adult)

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. The percent of selected surgical patients with appropriate surgical site hair removal during this reporting period. Based on the evidence no surgical site hair removal, or surgical site hair removal with clippers is considered appropriate within two hours of surgery. If hair removal is necessary, clippers (not razors) should be used. Ideally, hair removal should occur outside of the OR theatre or procedure room, but inside of the operating room department, within two hours of surgery. Depilatory is considered impractical. Hair removal at home and shaving are considered inappropriate.

1	Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.	
2	Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.	
3	Subtract the total number of patients who were admitted for treatment of burns or for organ transplantation.	
4	Enter the total number of patients included in this sample after exclusions.	
Denominator		
	Detail worksheet (optional)	
5	**Enter the total number of patients included in this sample after exclusions.**	
Numerator		
6	Indicate the number of patients with **No hair removal**.	
7	Indicate the number of patients with hair removal done with **Clippers**.	
8	Indicate the number of patients with hair removal done with **Depilatory**.	
9	Indicate the number of patients with hair removal done with **Razor**.	
10	Indicate the number of patients with **Hair removal done at home**.	
11	**Enter the total number of patients with no surgical site hair removal, or with hair removal with clippers or depilatory.**	
Your Result		
12	Numerator/Denominator x 100 = %	Your Result
		Goal 95% or higher

4.0 Per cent of Surgical Patients with Appropriate Hair Removal – Technical Description

***wound type not specified**

Intervention(s): Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
The per cent of selected clean and clean-contaminated surgical patients with appropriate surgical site hair removal during this reporting period. Based on the evidence no surgical site hair removal or surgical site hair removal with clippers is considered appropriate within two hours of surgery. If hair removal is necessary, clippers (not razors) should be used. Ideally, hair removal should occur outside of the OR theatre or procedure room, but inside of the operating room department, within two hours of surgery. Depilatory is considered impractical. Hair removal at home and shaving are considered inappropriate.

Standard Goal: 95% or higher

Note: Sustain the percentage of surgical patients with appropriate hair removal at 95% or higher.

CALCULATION DETAILS:

Numerator Definition: Number of selected surgical patients with no surgical site hair removal, or hair removal with the use of clippers or depilatory

Numerator Exclusions:

- Same exclusions as for denominator and
- Hair removal using razor
- Hair removal done at home

Denominator Definition: Number of selected surgical patients

Denominator Exclusions:

- Patients who are less than 18 years of age
- Burn or transplant patients

Compliance Bundle: The data collected for this indicator is available for the individual responses and presented as a Compliance Run Chart with the performance for each response category displayed separately. The data are also available in tabular format.

Bundle Elements include:

- No hair removal
- Clippers
- Depilatory
- Razor
- Hair removal done at home

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form:

DCF Response Options – SSI 4 (*numerator)

- *No hair removal
- *Clippers
- *Depilatory
- Razor
- Hair removal done at home

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: No. of clean or clean-contaminated pts. having 'no hair removal, or pre-operative hair removal using clippers or depilatory in hospital ---------- Total number of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated *Surgical Patients with Appropriate Hair Removal*

Comments :

Safer Healthcare Now! recommends:

- Patients should be educated not to shave or use a depilatory agent in the vicinity of the surgical site before surgery.[74] Incorporate this message into the printed preoperative patient information and surgeon's office communication
- Remove all razors from the hospital once clippers have been introduced. Work with the purchasing department so that razors are no longer purchased by the hospital
- Implement reminder posters throughout the operating theatre and surrounding patient support areas
- Clipping should occur less than two hours before surgery in an effort to limit bacterial contamination of the surgical site[37]

- The AORN guidelines report that hair should be removed outside of the operating room theatre or procedure room to limit hairs from contaminating OR tables and/or the surgical wound.[74] We recognize that this is a challenge given that most OR departments do not have private facilities to remove hair outside the operating room Theatre

- It may be necessary to remove hair in the operating room theatre or on a gurney in an OR holding area. Regardless of location, using adhesive gloves or other methods to remove stray hairs after clipping is important.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommend that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

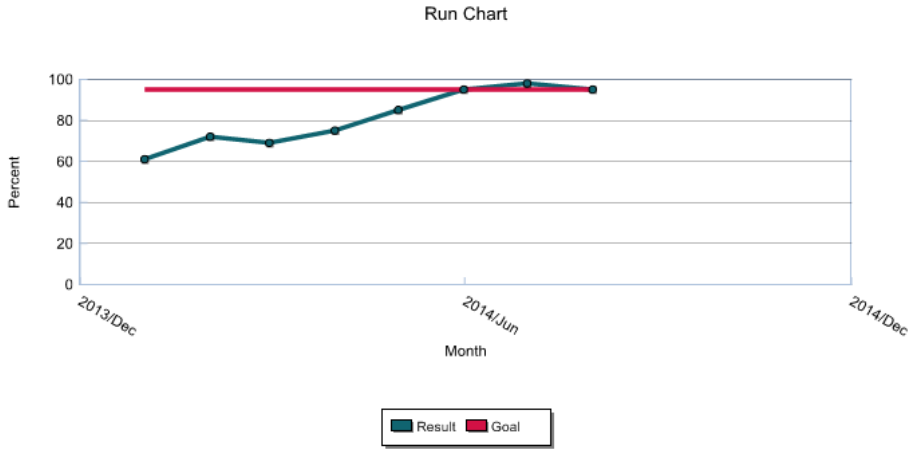
Sample Run Chart:

SSI 4 - Percentage of Surgical Patients with Appropriate Hair Removal

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	100	95	95.00%	
2014/Jul	100	98	98.00%	
2014/Jun	100	95	95.00%	Added note regarding no hair removal at home to pre-op instruction
2014/May	100	85	85.00%	Removed Razors from OR and Surgical Nursing Units
2014/Apr	100	75	75.00%	
2014/Mar	100	69	69.00%	
2014/Feb	100	72	72.00%	
2014/Jan	100	61	61.00%	

SSI 5.0 Per cent of All Diabetic or Surgical Patients at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2: Sample Measurement Worksheet

SSI 5 - Percentage of Surgical Patients who are diabetic or at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2 (In Patient, Adult)

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. The percentage of surgical patients who are diabetic or at risk of high blood glucose whose serum glucose is under control during this reporting period. The recommended level for post-operative serum glucose has been changed to "below 11.1 mmol/L". Blood glucose values should be measured on POD 0, 1 and 2 as the data are available i.e. prior to discharge.

1 Identify the total number of patients who had a Major Cardiac inpatient surgical procedure or other type of major surgical procedure as indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.

2 Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.

3 Subtract the total number of patients who had principal diagnostic codes or admission diagnosis suggestive of preoperative infectious disease.

4 Subtract the total number of patients who were admitted for treatment of burns or for organ transplantation.

5 Enter the total number of patients included in this sample after exclusions.

Denominator

Detail worksheet (optional)

6 **Enter the total number of patients included in this sample after exclusions.** [ ]

Numerator

7 **Enter the total number of surgical patients in the denominator with a controlled post-operative glucose level of less than 11.1 mmol/L measured on post-operative day (POD) 0, 1 and 2 at or closest to 0600.** [ ]

Your Result

8 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95% or higher

5.0 Per cent of Surgical Patients who are diabetic or at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2: Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
The percentage of surgical patients who are diabetic or at risk of high blood glucose whose serum glucose is under control during this reporting period. The recommended level for post-operative serum glucose has been changed to "below 11.1 mmol/L". Blood glucose values should be measured on POD 0, 1 and 2 as the data are available i.e. prior to discharge

Standard Goal: 95% or higher

Note: Increase the per cent of surgical patients (including major cardiac) with controlled post-operative serum glucose at 95 per cent or higher at the end of 2014 and sustain it every year thereafter

CALCULATION DETAILS:

Numerator Definition: Number of surgical patients who are diabetic or at risk of high blood glucose whose serum glucose is controlled of less than 11.1 mmol/L on post-operative day 0, 1 and 2 at or closest to 0600.

Numerator Exclusions:

- Same exclusions as for denominator
- Postop glucose >11.0 mmol/L on any of POD 0, 1 or 2
- Glucose not measured post operatively

Denominator Definition: All surgical patients

Denominator Exclusions:

- Patients who are less than 18 years of age
- Patients who are not diabetic or not a high risk of hyperglycemia
- Patients who had a principal or admission diagnosis suggestive of pre-operative infectious diseases
- Patients with physician-documented infection prior to surgical procedure
- Burn or transplant patients

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form:

DCF Response Options – SSI 5 (*numerator)

- Not at Risk
- *Yes
- No
- Glucose Not Done

Measurement Period: Monthly

Definition of Terms:

- **Controlled perioperative glucose:** The blood glucose values on post-operative day (POD) one and two drawn closest to 6:00 a.m. (0600)

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of clean or clean-contaminated pts. who are diabetic or All Diabetic or Surgical Patients at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2 --- Total number of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated *Surgical Patients who are diabetic or All Diabetic or Surgical Patients at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2*

Comments:

- Blood glucose values on POD 0, 1 and 2 must be below 11.1 mmol/L for the patient to be included in the numerator; an average glucose value of below 11.1 mmol/L is not sufficient
- Perioperative blood glucose levels be monitored on all surgical patients who are diabetic or have risk factors for diabetes
- Blood glucose should not drop below 6.1mmol/li.
- Begin glucose maintenance protocols 24 to 48 hours before surgery – develop protocols to advocate that patients and families control their pre-operative glucose levels at home
- All diabetic patients or patients with risk factors for diabetes should have a capillary blood glucose (CBG) level drawn during their pre-operative clinic visit
- Diabetics, and anyone with a CBG >10 mmol/L should be flagged to have a repeat CBG drawn the day of surgery (these patients should have CBG done every two hours intraoperatively)[1]

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

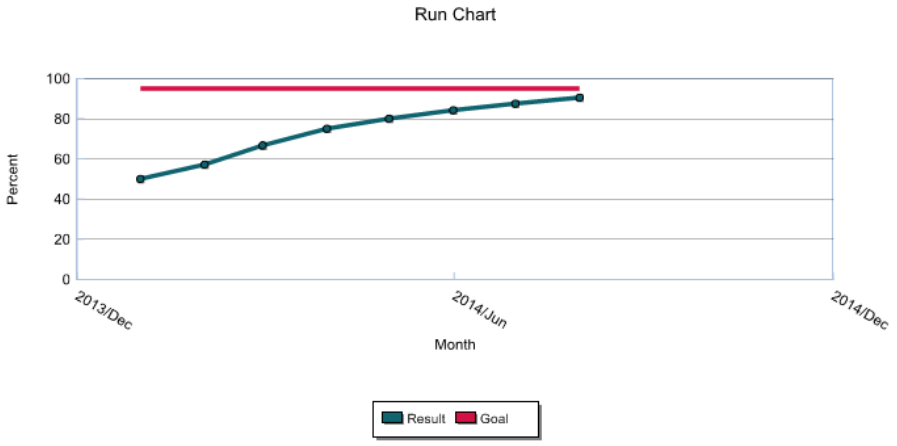
Sample Run Chart:

SSI 5 - Percent of All Diabetic or Surgical Patients at risk of high blood glucose with controlled post-operative serum glucose POD 0, 1, and 2

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	42	38	90.48%	
2014/Jul	48	42	87.50%	
2014/Jun	38	32	84.21%	Surgical ICU rounds on postop glucose
2014/May	50	40	80.00%	
2014/Apr	44	33	75.00%	Rounds on post-op glocose
2014/Mar	45	30	66.67%	
2014/Feb	35	20	57.14%	
2014/Jan	40	20	50.00%	

6.0 Per cent of Clean or Clean-Contaminated Surgical Patients with normothermia within 15 minutes prior to skin closure or on arrival in PACU: Sample Measurement Worksheet

SSI 6 - Percentage of Clean or Clean-Contaminated Surgical Patients with normothermia within 15 minutes prior to skin closure or on arrival in PACU ()

Year [ ] Month [ ]

Effective September 2014 this measure has been revised. The percentage of all clean or clean-contaminated surgical patients during this reporting period with normothermia (36.0° - 38.0°C) within 15 minutes before the end of surgery i.e. wound closure. However if the temperature is not available within 15 minutes of the end of surgery the alternate temperature is on arrival in the post-anaesthesia care unit (PACU).

1 Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.

2 Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.

3 Subtract the total number of patients who had principal diagnostic codes or admission diagnosis suggestive of preoperative infectious disease.

4 Subtract the total number of patients who were admitted for treatment of burns or for organ transplantation.

5 Enter the total number of patients included in this sample after exclusions.

Denominator

Detail worksheet (optional)

6 **Enter the total number of patients included in this sample after exclusions.** [ ]

Numerator

7 **What is the total number of surgical patients in the denominator whose temperature within 15 minutes prior to wound closure or, if not available, on arrival in PACU was within the range of 36.0° - 38.0°C.** [ ]

Your Result

8 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95% or higher

6.0 Per cent of clean or clean-contaminated surgical patients with normothermia within 15 minutes prior to skin closure or on arrival in PACU – Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***Effective September 2014 this measure has been revised***
The percentage of clean or clean-contaminated surgical patients during this reporting period with normothermia (36.0° - 38.0°C) within 15 minutes before the end of surgery (i.e. wound closure). However if the temperature is not available within 15 minutes of the end of surgery the alternate temperature is on arrival in the post-anaesthesia care unit (PACU).

Note: There can be a discrepancy in core temperatures measured by the gold standard methods and the other methods, but overall the thermometers should correlate if used consistently (i.e. temporal thermometer generally reads higher and the tympanic thermometer generally reads lower). See the Perioperative Normothermia section on page 33.

Standard Goal: 95% or higher

Note: Increase the per cent of surgical patients with Post-Operative Normothermia at 95 per cent or higher at the end of 2014 and maintain it every year thereafter

CALCULATION DETAILS:

Numerator Definition: Number of surgical patients whose temperature within 15 minutes prior to wound closure or, if not available, on arrival in PACU were within the range of 36 to 38ºC or 96.8 to 100.4ºF

Numerator Exclusions:

- Same exclusions as for denominator
- Temperature not within target range within 15 minutes of end of surgery or on arrival in PACU
- Temperature not recorded

Denominator Definition: All surgical patients

Denominator Exclusions:

- Patients who are less than 18 years of age
- Burn or transplant patients
- Patients who had a principal or admission diagnosis suggestive of pre-operative infectious diseases

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System.

The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form.

DCF Response Options – SSI 6 (*numerator)

- *Yes
- No
- *Induced Hypothermia
- Not Recorded

Measurement Period: Monthly

Definition of Terms:

- **Normothermia:** Core temperature 36-38 º C or 96.8-100.4 º F.

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: No. of clean or clean-contaminated pts. with normothermia within 15 minutes of end of surgery or on arrival in PACU or induced hypothermia --- Total number of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* clean or clean-contaminated *Surgical Patients with normothermia within 15 minutes of end of surgery or on arrival in PACU*

Comments:

Normothermia (core temperature 36^0C to38^0C) should be maintained pre-operatively, intraoperatively, and in PACU by implementing any combination of the following:

- Pre-printed order sets to ensure pre-warming
- Active Pre-warming AND Intra-op warming is indicated when surgery is expected to last >30 minutes[137]
- Warmed Intravenous fluids for abdominal surgeries expected to last more than one hour[137]
- Warmed lavage liquids for colorectal surgery
- Increase the ambient temperature in the operating room to 20-23^0C (ORNAC standards) [138]
- Hats and booties on patients during surgery

Pre-warming should be initiated between 30 minutes to two hours prior to major surgery. Recent literature has shown that even only 10 minutes of pre-warming makes a difference.[139] The optimal duration of pre-warming has not been determined.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

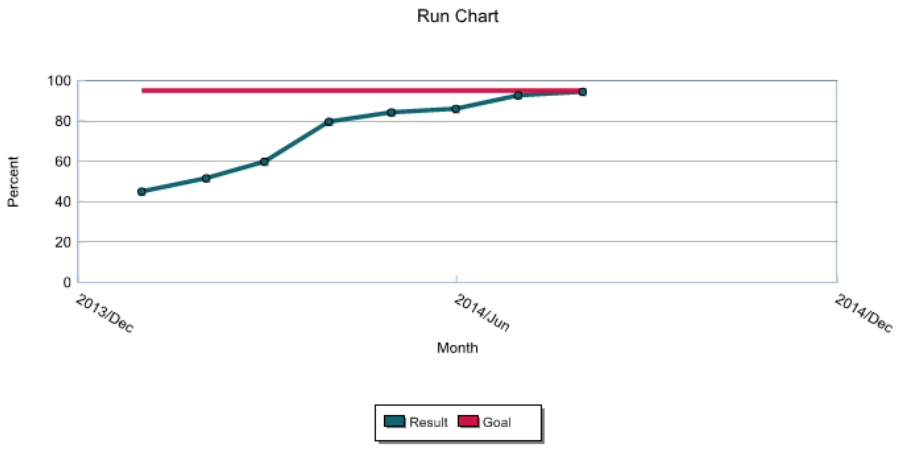
Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

Sample Run Chart:

SSI 6 - Percent of Clean or Clean-Contaminated Surgical Patients with normothermia within 15 minutes prior to skin closure or on arrival in PACU

Export To CSV | Back

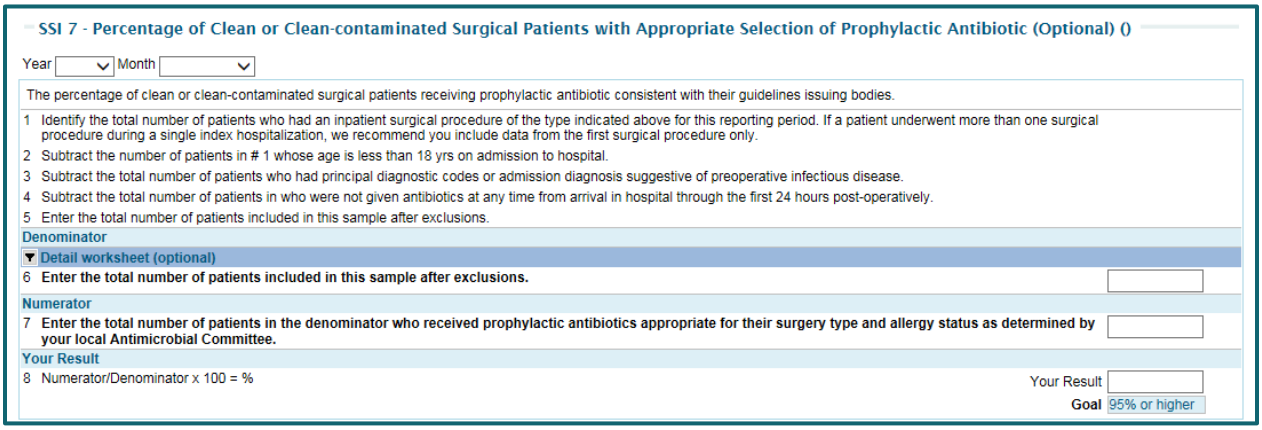
Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	90	85	94.44%	
2014/Jul	95	88	92.63%	
2014/Jun	100	86	86.00%	
2014/May	95	80	84.21%	
2014/Apr	98	78	79.59%	Workshop conducted with all OR staff regarding intraoperative normothermia
2014/Mar	92	55	59.78%	
2014/Feb	95	49	51.58%	
2014/Jan	100	45	45.00%	

7.0 Per cent of Clean or Clean-contaminated Surgical Patients with Appropriate Selection of Prophylactic Antibiotic (Optional): Sample Measurement Worksheet



SSI 7 - Percentage of Clean or Clean-contaminated Surgical Patients with Appropriate Selection of Prophylactic Antibiotic (Optional) ()

Year [ ] Month [ ]

The percentage of clean or clean-contaminated surgical patients receiving prophylactic antibiotic consistent with their guidelines issuing bodies.

1 Identify the total number of patients who had an inpatient surgical procedure of the type indicated above for this reporting period. If a patient underwent more than one surgical procedure during a single index hospitalization, we recommend you include data from the first surgical procedure only.
2 Subtract the number of patients in # 1 whose age is less than 18 yrs on admission to hospital.
3 Subtract the total number of patients who had principal diagnostic codes or admission diagnosis suggestive of preoperative infectious disease.
4 Subtract the total number of patients in who were not given antibiotics at any time from arrival in hospital through the first 24 hours post-operatively.
5 Enter the total number of patients included in this sample after exclusions.

Denominator

Detail worksheet (optional)

6 **Enter the total number of patients included in this sample after exclusions.** [ ]

Numerator

7 **Enter the total number of patients in the denominator who received prophylactic antibiotics appropriate for their surgery type and allergy status as determined by your local Antimicrobial Committee.** [ ]

Your Result

8 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95% or higher

7.0 (Optional Measure) Per cent of Clean or Clean-contaminated Surgical Patients with Appropriate Selection of Prophylactic Antibiotic – Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: The percentage of clean or clean-contaminated surgical patients receiving prophylactic antibiotic consistent with their guidelines issuing bodies [2∞]

Standard Goal: 95% or higher

Timeline: Standard goal should be achieved every year

CALCULATION DETAILS:

Numerator Definition: Number of patients in the denominator who received prophylactic antibiotics appropriate for their surgery type and allergy status as determined by your local Antimicrobial Committee

Numerator Exclusions: Same exclusions as for denominator exclusions

Denominator Definition: Number of selected surgical patients included in this sample after exclusions

Denominator Exclusions:

- Patients less than 18 years of age
- Existing infectious process at the same site as the surgical procedure or surgeries that are classified as wound class 3 or 4[€] (NHSN – see **Appendix D**)
- Patients who were not given antibiotics at any time from arrival in hospital through the first 24 hours post-operatively

Data Collection (Audit) Form: This measure is not collected through the use of the data collection form.

Measurement Period: Monthly

Calculate as: (numerator/denominator); as a percentage

[∞] Please consult with your local drugs and therapeutics committee on the selection of guidelines consistent with your locally approved recommendations. Common references are: The Medical Letter on Drugs and Therapeutics[2], American Society of Health-System Pharmacists (ASHP) Therapeutic Guidelines, Canadian *Bugs and Drugs 2006* Antimicrobial Reference, Blondel-Hill & Fryters, www.bugsanddrugs.ca), JCAHO/CMS guidelines, Centres for Disease Control(CDC), Scottish Intercollegiate Guidelines.

[€] Please see **Appendix D** for definitions

Example of the Calculation: No. of clean or clean-contaminated pts. with appropriate prophylactic antibiotics for their type of surgery and personal profile --- Total number of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean or Clean-contaminated *surgical patients with Appropriate Selection of Prophylactic Antibiotic*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

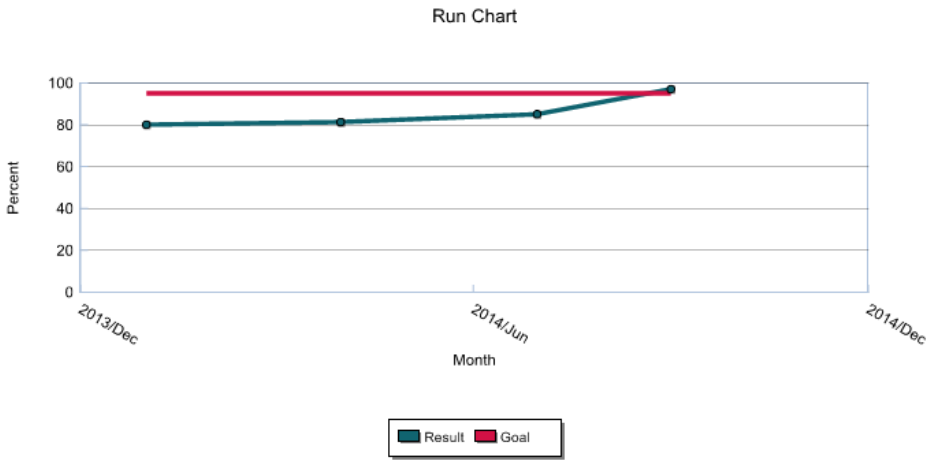
Sample Run Chart:

SSI 7 - Percentage of Clean or Clean-contaminated Surgical Patients with Appropriate Selection of Prophylactic Antibiotic

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 4 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Sep	100	97	97.00%	
2014/Jul	100	85	85.00%	
2014/Apr	80	65	81.25%	
2014/Jan	50	40	80.00%	

8.0 Per cent of Clean and Clean-Contaminated Caesarean Section Patients with Timely Prophylactic Antibiotic Administration - Sample Measurement Worksheet

SSI 8 - Percentage of Clean and Clean-Contaminated Caesarean Section Patients with Timely Prophylactic Antibiotic Administration (In Patient, Adult)

Year [ ] Month [ ]

New Measure September 2014. The percentage of clean and clean-contaminated Caesarean Section (C-Section) patients receiving timely prophylactic antibiotics administered within 60 minutes prior to the surgical incision during this reporting period. The auditor should measure the timing of antibiotic administration from antibiotic start time to surgical (incision) start time. If either time is missing, count as NOT obtaining prophylactic antibiotics on time.

Denominator

1 **What is the total number of C-Section patients sampled for this reporting period?** [ ]

Numerator

2 Enter the the total number of C-Section patients whose prophylactic antimicrobial was vancomycin which was administered over 120 minutes and completed within 0 to 60 minutes prior to the first surgical incision time. [ ]

3 Enter the total number of C-Section patients in whose prophylactic antimicrobial was any antibiotic other than vancomycin and administation was completed within 0 to 60 minutes prior to the first surgical incision time. [ ]

4 **What is the total number of C-Section patients in this sample for whom timely prophylactic antibiotics were administered for this reporting period?** [ ]

Your Result

5 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95%

8.0 Per cent of Clean and Clean-Contaminated Caesarean Section Patients with Timely Prophylactic Antibiotic Administration - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The percentage of clean and clean-contaminated patients receiving timely prophylactic antibiotic administration delivered within 60 minutes prior to the surgical incision and ideally completely infused before tourniquet inflation during this reporting period. The prophylactic antibiotic infusion is to be started and completed within 60 minutes for most antibiotics or infused within 120 minutes for vancomycin and fluoroquinolones prior to skin incision or application of tourniquet.

For C-sections, prophylactic antibiotics should be started and completed within 60 minutes prior to the first incision rather than after cord clamping. The auditor should measure the timing of the antibiotic administration from antibiotic start time to surgical (incision) start time. If either time is missing, count as NOT obtaining prophylactic antibiotics on time.

Standard Goal: 95% or higher

Note: Sustain the percentage of surgical patients with timely prophylactic antibiotic administration at 95% or higher.

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated Caesarian section patients whose antibiotic administration were started and completed within 60 minutes prior to surgical incision not cord clamp.

Note: Cases for which either vancomycin or a fluoroquinolone were used as prophylactic antimicrobial: These antibiotics need to be started and infused over 120 minutes (to avoid Red Man Syndrome). The infusion needs to be completed up to 60 minutes before first surgical incision. Patients who receive these antibiotics up to 60 minutes before first incision will count in the numerator.

Note for C-Section: Cefazolin is the most common prophylactic antibiotic used for C-section. Clindamycin and Gentamycin is the B-lactam allergy alternate to cefazolin. If the mother is unable to tolerate Clindamycin, Vancomycin (+ metronidazole) would be a reasonable alternative. Fluroquinolones are contraindicated in neonates.

Numerator Exclusions:

- Same exclusions as for denominator
- No prophylactic antibiotics given
- Infusion of prophylactic antibiotics completed after the first incision or tourniquet inflation

Denominator Definition: Number of C-Section patients sampled for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)
- All surgical procedures other than Caesarian Section

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form:

DCF Response Options – SSI 8 (*numerator) **C-Section only**

- *within 60 minutes before incision
- *within 120 minutes before incision for Vancomycin or Fluoroquinolones
- None of the above
- No antibiotics given

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of Clean and Clean-contaminated C-Section patients. with antibiotic infusion started and completed within 60 minutes of incision --- Total no. of Clean and Clean-contaminated C-Section patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated *C-Section Patients with Timely Prophylactic Antibiotic Administration*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.
- If more than one inpatient surgical procedure occurred during the index hospitalization, only the first surgical procedure should be considered for the purposes of this measure.

- The auditor should measure the timing of the antibiotic administration from antibiotic start time to surgical (incision) start time.
- For cases involving use of an inflatable cuff or tourniquet applied to the operative site, the antibiotic should be fully infused prior to inflation of the cuff.
- If you are using a surgical checklist in your OR, consider adding "Antibiotic Prophylaxis: fully infused?" to the Briefing section.
- If you have two antibiotics you count the infusion time of the last antibiotic administered.

Note: Patients for whom antibiotic start time or incision time is not recorded are counted as not obtaining prophylactic antibiotics on time (i.e., a zero in the numerator).

***Please Note:* The following information on collection strategy and sampling strategy and graphs pertains to all of the measurements contained within **Appendix C**.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommend that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

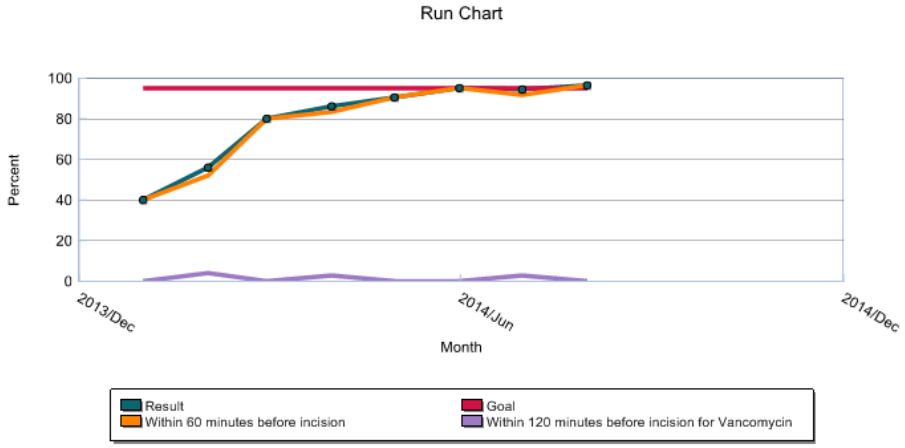
Sample Run Chart:

SSI 8 - Percent of Clean and Clean-Contaminated Caesarean Section Patients with Timely Prophylactic Antibiotic Administration for C-Section

In Patient, Adult

Export To CSV | Back

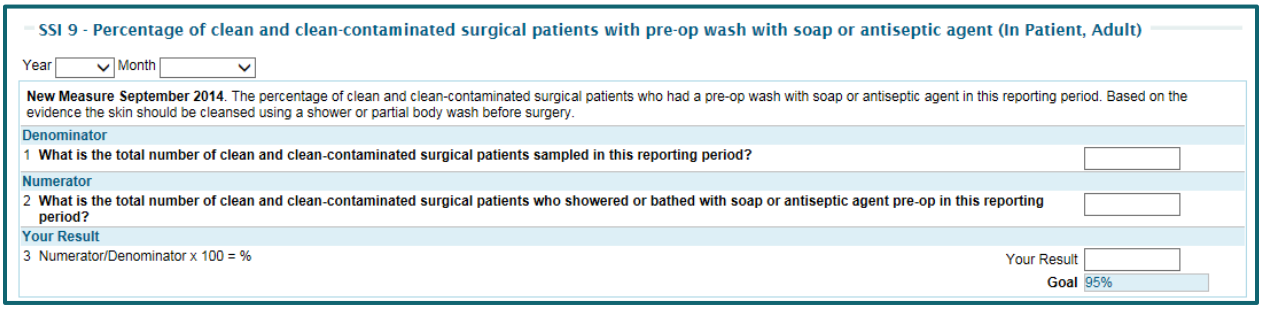
Note: Exports data table only.



Report Return: 8 record(s)

Month	Numerator	Denominator	Result	Within 60 minutes before incision	Within 120 minutes before incision for Vancomycin	None of the above	No antibiotics given
2014/Aug	27	28	96.43%	96.43%	0%		
2014/Jul	34	36	94.44%	91.67%	2.78%		
2014/Jun	39	41	95.12%	95.12%	0%		
2014/May	38	42	90.48%	90.48%	0%		
2014/Apr	31	36	86.11%	83.33%	2.78%		
2014/Mar	32	40	80.00%	80%	0%		
2014/Feb	14	25	56.00%	52%	4%		
2014/Jan	12	30	40.00%	40%	0%		

9.0 Per cent of clean and clean-contaminated surgical patients with pre-op wash with soap or antiseptic agent: Sample Measurement Worksheet



SSI 9 - Percentage of clean and clean-contaminated surgical patients with pre-op wash with soap or antiseptic agent (In Patient, Adult)

Year [ ] Month [ ]

New Measure September 2014. The percentage of clean and clean-contaminated surgical patients who had a pre-op wash with soap or antiseptic agent in this reporting period. Based on the evidence the skin should be cleansed using a shower or partial body wash before surgery.

Denominator

1 **What is the total number of clean and clean-contaminated surgical patients sampled in this reporting period?** [ ]

Numerator

2 **What is the total number of clean and clean-contaminated surgical patients who showered or bathed with soap or antiseptic agent pre-op in this reporting period?** [ ]

Your Result

3 Numerator/Denominator x 100 = % Your Result [ ]

Goal 95%

9.0 Per cent of clean and clean-contaminated surgical patients with pre-op wash with soap or antiseptic agent - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The percentage of clean and clean-contaminated surgical patients who had a pre-op wash with soap or antiseptic agent in this reporting period. Based on the evidence the skin should be cleansed using a shower or partial body wash before surgery.

Standard Goal: 95% or higher

Note: Sustain the percentage of clean and clean-contaminated surgical patients with pre-op wash with soap or antiseptic agent at 95% or higher every year

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated who had a pre-op wash with soap or antiseptic agent in this reporting period

Note: Although pre-operative bathing (whole-body disinfection) with antiseptic agents has not been shown to reduce the incidence of SSI rates,[1, 27, 89] it has been shown to reduce bacterial counts on the skin.[90] It is recommended that patients should shower or bathe with either soap or an antiseptic agent at least the night before the operative day.

Numerator Exclusions:

- Same exclusions as for denominator
- No shower or bath
- No record of agent used

Denominator Definition: Number of clean and clean-contaminated surgical patients sampled in this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System.

The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form.

DCF Response Options – SSI 9 (*numerator)

- *Soap
- *Antiseptic Agent
- Shower or Bath not required
- No shower or bath
- Not Recorded

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: No. of Clean and Clean-contaminated surgical pts. with pre-op wash using soap or an antiseptic agent --- Total no. of Clean and Clean-contaminated C-Section pts. in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated *Surgical Patients with pre-op wash using soap or an antiseptic agent*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.

***Please Note:* The following information on collection strategy and sampling strategy and graphs pertains to all of the measurements contained within **Appendix C**.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

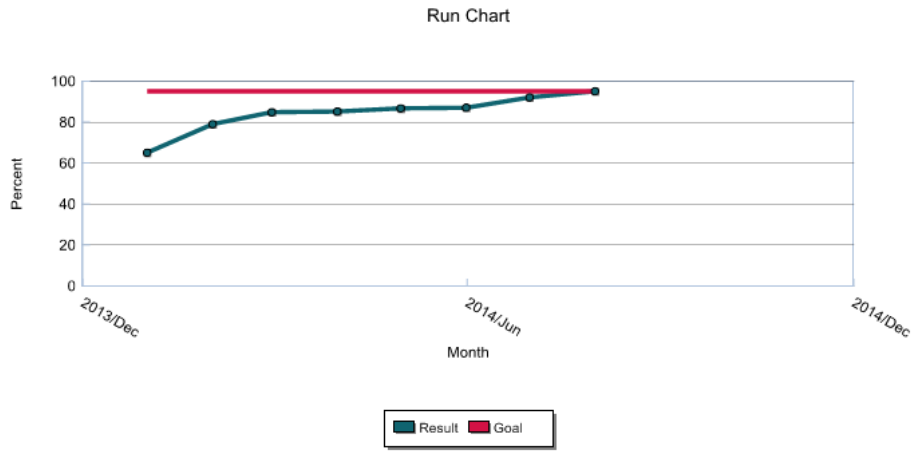
Sample Run Chart:

SSI 9 - Percent of clean and clean-contaminated surgical patients with pre-op wash with soap or antiseptic agent

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	100	95	95.00%	
2014/Jul	100	92	92.00%	
2014/Jun	92	80	86.96%	
2014/May	90	78	86.67%	
2014/Apr	94	80	85.11%	
2014/Mar	92	78	84.78%	
2014/Feb	95	75	78.95%	
2014/Jan	100	65	65.00%	

10.0 Per cent of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin - Sample Measurement Worksheet

SSI 10 - Percentage of Clean and Clean-Contaminated Surgical Patients with Appropriate Intra-op Skin Cleansing on Intact Skin (In Patient, Adult)

Year [ ] Month [ ]

New Measure September 2014. The percentage of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin in this reporting period. Based on available evidence, **2% Chlorhexidine in 70% alcohol** antiseptic solution is the preferred agent unless contraindicated i.e. not mucosa or rash or close to eyes or ears. Other alcohol-based solutions (povidone -iodine) are acceptable.

Denominator		
1	**What is the total number of clean and clean-contaminated surgical patients sampled for this reporting period?**	
Numerator		
2	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **2% Chlorhexidine in 70% alcohol**.	
3	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Chlorhexidine**.	
4	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Povidone-iodine with alcohol**.	
5	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Povidone-iodine**.	
6	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Other**.	
7	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Contraindicated**.	
8	Enter the total number of patients where solution used for intra-operative intact skin cleansing was **Not Recorded**.	
9	**What is the total number of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin (2% Chlorhexidine in 70% alcohol, Povidone-iodine with alcohol, or Contraindicated) for this reporting period?**	
Your Result		
10	Numerator/Denominator x 100 = %	Your Result
		Goal 95%

10.0 Per cent of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The percentage of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin in this reporting period. Based on available evidence, 2% Chlorhexidine in 70% alcohol antiseptic solution is the preferred agent unless contraindicated i.e. not mucosa or rash or close to eyes or ears. Other alcohol-based solutions (povidone-iodine) are acceptable.

Standard Goal: 95% or higher

Note: Sustain the percentage of clean and clean-contaminated surgical patients with **appropriate intra-op skin cleansing on intact skin** at 95% or higher.

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated who had appropriate intra-op skin cleansing on intact skin (2% Chlorhexidine in 70% alcohol, Povidone-iodine with alcohol, or Contraindicated) for this reporting period.

Note: Intra-operative skin preparation should be performed with an alcohol-based antiseptic agent, unless contraindicated. 2% CHG/70% IPA has repeatedly been shown to be the most effective surgical skin preparation solution for intact skin. Following application of chlorhexidine-alcohol skin preparation solution, surgical teams should allow at least three minutes for the skin preparations to air dry prior to first incision, or longer if there is excessive hair and should not be washed off at the end of surgery.

Numerator Exclusions:

- Same exclusions as for denominator
- Intra-operative skin cleansing using CHG or povidone-iodine without alcohol or any other agent
- Intra-operative skin cleansing agent was not recorded

Denominator Definition: Number of clean and clean-contaminated surgical patients sampled for the reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Compliance Bundle

The data collected for this indicator is available for the individual responses and presented as a Compliance Run Chart with the performance for each response category displayed separately. The data are also available in tabular format.

Bundle Elements include:

- 2% Chlorhexidine in 70% alcohol
- Chlorhexidine
- Povidone-iodine with alcohol
- Povidone-iodine
- Other
- Contraindicated
- Not Recorded

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 10 (*numerator)

- *2% Chlorhexidine in 70% alcohol
- Chlorhexidine
- *Povidone-iodine with alcohol
- Povidone-iodine
- Other
- *Contraindicated
- Not Applicable
- Not Recorded

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of Clean and Clean-contaminated surgical pts. who had appropriate intra-op skin cleansing on intact skin (2% Chlorhexidine in 70% alcohol, povidone-iodine with alcohol, or Contraindicated) --- Total no. of Clean and Clean-contaminated surgical patients. in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-contaminated *Surgical Patients with appropriate intra-op skin cleansing on intact skin*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.
- Intra-operative skin preparation should be performed with an alcohol-based antiseptic agent, unless contraindicated
- Two per cent chlorhexidine with 70 per cent isopropyl alcohol (2% CHG/70% IPA) has repeatedly been shown to be a more effective surgical skin preparation solution than any other
- Alcohol-based antiseptics are flammable and therefore require caution when in use including educating staff, avoid dripping or pooling, allow to completely air dry and be sure to notify OR colleagues that they are in use.
- Avoid contact with eyes and inside the ear

***Please Note:* The following information on collection strategy and sampling strategy and graphs pertains to all of the measurements contained within **Appendix C**.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

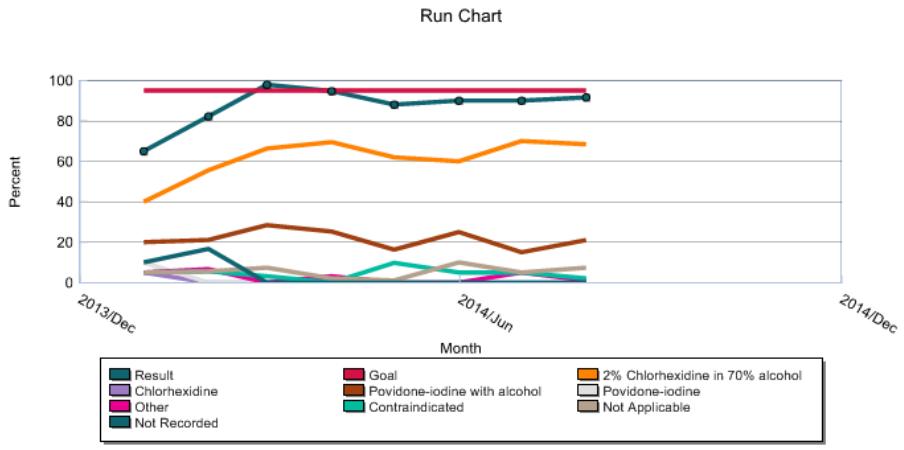
Sample Run Chart

SSI 10 - Percent of clean and clean-contaminated surgical patients with appropriate intra-op skin cleansing on intact skin

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Numerator	Denominator	Result	2% Chlorhexidine in 70% alcohol	Chlorhexidine	Povidone -iodine with alcohol	Povidone -iodine	Other	Contraindicated	Not Applicable
2014/Aug	87	95	91.58%	68.42%	0%	21.05%	0%	1.05%	2.11%	7.37%
2014/Jul	90	100	90.00%	70%	0%	15%	0%	5%	5%	5%
2014/Jun	90	100	90.00%	60%	0%	25%	0%	0%	5%	10%
2014/May	81	92	88.04%	61.96%	0%	16.3%	0%	0%	9.78%	1.09%
2014/Apr	90	95	94.74%	69.47%	0%	25.26%	0%	3.16%	0%	2.11%
2014/Mar	93	95	97.89%	66.32%	0%	28.42%	0%	0%	3.16%	7.37%
2014/Feb	74	90	82.22%	55.56%	0%	21.11%	0%	6.67%	5.56%	5.56%
2014/Jan	65	100	65.00%	40%	5%	20%	10%	5%	5%	5%

11.0 Per cent of Clean and Clean-Contaminated Adult Patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic: Sample Measurement Worksheet

SSI 11 - Percentage of Clean and Clean-Contaminated Adult Surgical Patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic (In Patient, Adult)

Year [ ] Month [ ]

New Measure September 2014. The percentage of clean and clean-contaminated **adult** surgical patients receiving 2 grams cefazolin as prophylactic antibiotic during this reporting period. In the *clinical practice guidelines for antimicrobial prophylaxis in surgery*, Bratzler et al recommends increasing the dose of cefazolin from 1 g to 2 g for patients weighing more than 80 kg, and to 3 g for those weighing 120 kg or more. However the recommendation to give 3 g is based on expert opinion and available evidence suggests 3 g is not necessary regardless of body mass index (BMI) 0.47. For simplification and because of the relatively nontoxic nature of cefazolin and the high percentage of obese surgical patients, some Canadian hospitals have standardized to 2 g cefazolin doses for all adult patients when antibiotic prophylaxis is indicated.

Denominator		
1	**What is the total number of clean and clean-contaminated adult surgical patients sampled receiving Cefazolin as Prophylactic Antibiotic for this reporting period?**	
Numerator		
2	Enter the total number of adult patients with a Dose of Cefazolin used as Prophylactic Abx of **1g**.	
3	Enter the total number of adult patients with a Dose of Cefazolin used as Prophylactic Abx of **2g**.	
4	Enter the total number of adult patients with a Dose of Cefazolin used as Prophylactic Abx of **3g**.	
5	**What is the total number of clean and clean-contaminated adult surgical patients sampled receiving 2 grams of Cefazolin as Prophylactic Antibiotic for this reporting period?**	
Your Result		
6	Numerator/Denominator x 100 = %	Your Result
		Goal 95%

11.0 Per cent of Clean and Clean-Contaminated Adult Patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The percentage of clean and clean-contaminated patients receiving 2 grams cefazolin as prophylactic antibiotic during this reporting period. In the clinical practice guidelines for antimicrobial prophylaxis in surgery, Bratzler et al recommends increasing the dose of cefazolin from 1 g to 2 g for patients weighing more than 80 kg, and to 3 g for those weighing 120 kg or more. However the recommendation to give 3 g is based on expert opinion and available evidence suggests 3 g is not necessary regardless of body mass index (BMI) 0.47. For simplification and because of the relatively nontoxic nature of cefazolin and the high percentage of obese surgical patients, some Canadian hospitals have standardized to 2 g cefazolin doses for all adult patients when antibiotic prophylaxis is indicated.

Standard Goal: 95% or higher

Note: Sustain the percentage of clean and clean-contaminated surgical patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic at 95% or higher

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated surgical adult patients receiving 2g of Cefazolin as Prophylactic Antibiotic for this reporting period

Numerator Exclusions:

- Same exclusions as for denominator
- Receiving 1 gram or 3 grams of Cefazolin as prophylactic antibiotic

Denominator Definition: Number of clean and clean-contaminated surgical adult patients receiving Cefazolin as Prophylactic Antibiotic for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)
- Receiving any prophylactic antibiotic other than Cefazolin
- Name of prophylactic antibiotic given was not recorded

Compliance Bundle: The data collected for this indicator is available for the individual responses and presented as a Compliance Run Chart with the performance for each response category displayed separately. The data are also available in tabular format.

Bundle Elements include:

- 1 gram
- 2 grams
- 3 grams

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 11.0 (*numerator)

- 1g
- *2g
- 3g
- Other antibiotic used
- Not Recorded

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: No. of Clean and Clean-contaminated surgical adult pts. who received 2 grams of Cefazolin as prophylactic antibiotic --- Total no. of Clean and Clean-contaminated adult surgical patients receiving Cefazolin as prophylactic antibiotic in this reporting period	X 100 =	*Per cent of* Clean and Clean-Contaminated *Adult Surgical Patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.Antibiotic selected for each procedure should provide coverage for the majority of organisms likely to be encountered during the procedure but it does not need to eradicate every potential pathogen to be effective.
- The selection of antibiotic for prophylaxis should also take into consideration the patient's colonization or infection with multi-drug resistant organisms

- Refer to **Table 1** for recommended appropriate dosing, timing, frequency and duration to achieve serum and tissue antibiotic concentrations that exceed the minimum inhibitory concentrations (MICs)

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

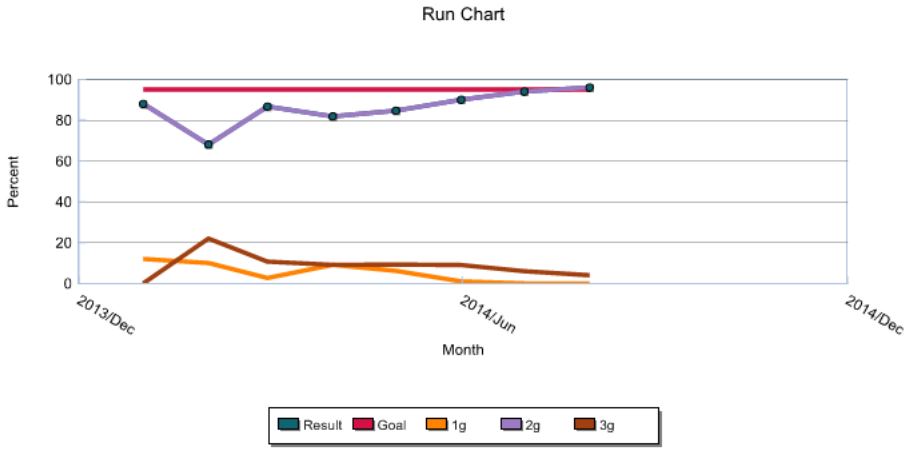
Sample Run Chart

SSI 11 - Percent of Clean and Clean-Contaminated Adult Patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Numerator	Denominator	Result	1g	2g	3g	Other antibiotic used	Not Recorded
2014/Aug	96	100	96.00%	0%	96%	4%		
2014/Jul	94	100	94.00%	0%	94%	6%		
2014/Jun	90	100	90.00%	1%	90%	9%		
2014/May	55	65	84.62%	6.15%	84.62%	9.23%		
2014/Apr	45	55	81.82%	9.09%	81.82%	9.09%		
2014/Mar	65	75	86.67%	2.67%	86.67%	10.67%		
2014/Feb	68	100	68.00%	10%	68%	22%		
2014/Jan	44	50	88.00%	12%	88%	0%		

12.0 Per cent of Clean and Clean-Contaminated Surgical Patients Receiving Appropriate Prophylactic Antibiotic re-dosing - Sample Measurement Worksheet

SSI 12 - Percentage of Clean and Clean-Contaminated Surgical Patients Receiving Appropriate Prophylactic Antibiotic Redosing (In Patient, Adult)

Year [ ] Month [ ]

New Measure September 2014. The percentage of clean and clean-contaminated surgical patients receiving appropriate prophylactic antibiotic redosing during this reporting period. Re-dosing of antibiotics may be required during prolonged surgery (more than two half-lives of the prophylactic antibiotic used) or procedures in which there is significant blood loss (more than 1.5 L) in order to maintain therapeutic levels perioperatively. Refer to the SSI Getting Started Kit, p20 - Table 1 (pg 20) for recommended re-dosing of prophylactic antibiotics.

The auditor should measure the timing of antibiotic administration from start time of the pre-operative antibiotic dose to time of the intraoperative antibiotic dose.

Denominator	
1 **What is the total number of clean and clean-contaminated surgical patients REQUIRING REDOSING of the prophylactic antiobiotic during surery for this reporting period?**	
Numerator	
2 **What is the total number of clean and clean-contaminated surgical patients RECEIVING appropriate prophylactic antibiotic REDOSING for this reporting period?**	
Your Result	
3 Numerator/Denominator x 100 = %	Your Result
	Goal 95%

12.0 Per cent of Clean and Clean-Contaminated Surgical patients receiving appropriate Prophylactic Antibiotic re-dosing - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The percentage of clean and clean-contaminated surgical patients receiving appropriate prophylactic antibiotic re-dosing during this reporting period. Re-dosing of antibiotics may be required during prolonged surgery (more than two half-lives of the prophylactic antibiotic used) or procedures in which there is significant blood loss (more than 1.5 L) in order to maintain therapeutic levels perioperatively. Refer to the SSI Getting Started Kit, - **Table 1** for recommended re-dosing of prophylactic antibiotics. The auditor should measure the timing of antibiotic administration from start time of the pre-operative antibiotic dose to time of the intraoperative antibiotic dose.

Standard Goal: 95% or higher

Note: Sustain the percentage of clean and clean-contaminated surgical patients receiving 2 grams of Cefazolin as Prophylactic Antibiotic at 95% or higher.

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated surgical patients receiving appropriate Prophylactic Antibiotic **re-dosing** for this reporting period

Numerator Exclusions:

- Same exclusions as for denominator
- Appropriate prophylactic antibiotic re-dosing not performed

Denominator Definition: Number of clean and clean-contaminated surgical patients receiving Cefazolin as Prophylactic Antibiotic for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)
- Prophylactic antibiotic not given
- Did not require re-dosing with Prophylactic antibiotic

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form:

DCF Response Options – SSI 12 (*numerator)

- No prophylactic antibiotic given
- *Yes
- No
- Re-dosing not required

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
No. of Clean and Clean-contaminated surgical pts. who received appropriate prophylactic antibiotic re-dosing --- Total no. of Clean and Clean-contaminated surgical patients eligible for prophylactic antibiotic re-dosing in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients receiving Prophylactic Antibiotic Re-dosing*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.Antibiotic selected for each procedure should provide coverage for the majority of organisms likely to be encountered during the procedure but it does not need to eradicate every potential pathogen to be effective.
- Refer to **Table 1** for recommended appropriate dosing, timing, frequency and duration to achieve serum and tissue antibiotic concentrations that exceed the minimum inhibitory concentrations (MICs)

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

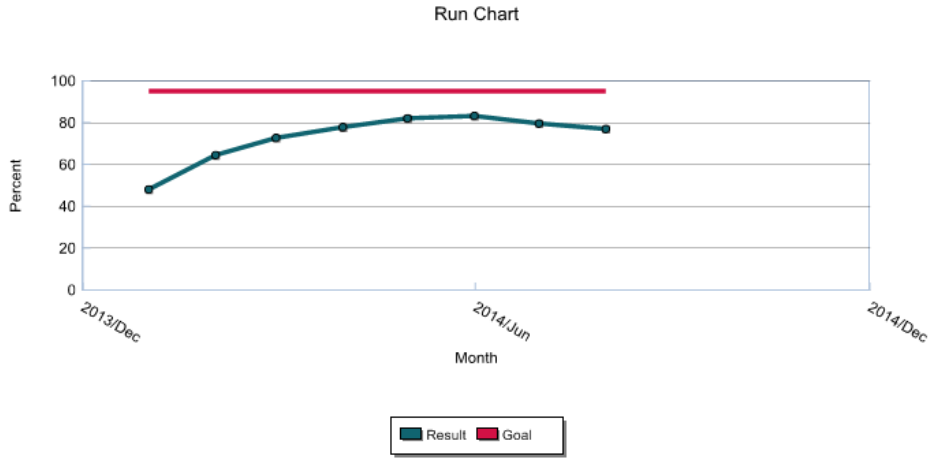
Sample Run Chart:

SSI 12 - Percent of Clean and Clean-Contaminated Surgical patients receiving appropriate Prophylactic Antibiotic redosing

In Patient, Adult

Export To CSV | Back

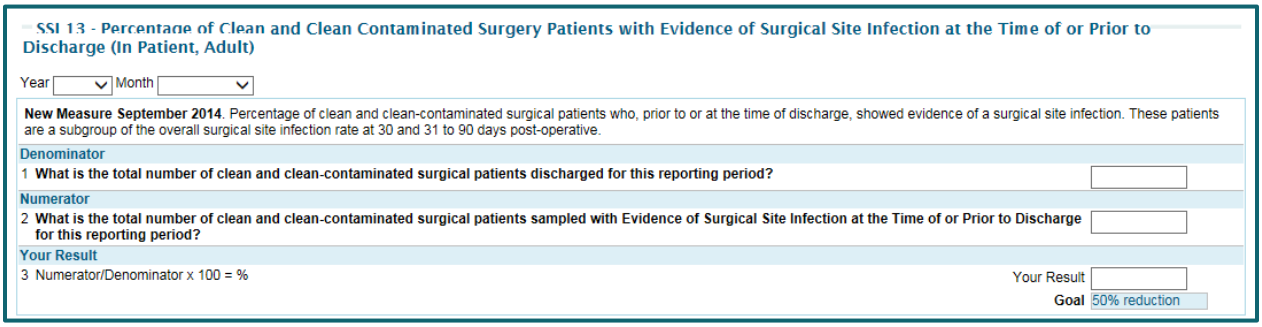
Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	91	70	76.92%	
2014/Jul	88	70	79.55%	
2014/Jun	95	79	83.16%	
2014/May	100	82	82.00%	
2014/Apr	90	70	77.78%	
2014/Mar	95	69	72.63%	
2014/Feb	90	58	64.44%	
2014/Jan	100	48	48.00%	

13.0 Per cent of Clean and Clean Contaminated Surgery Patients with Evidence of Surgical Site Infection at the Time of or Prior to Discharge - Sample Measurement Worksheet



SSI 13 - Percentage of Clean and Clean Contaminated Surgery Patients with Evidence of Surgical Site Infection at the Time of or Prior to Discharge (In Patient, Adult)

Year ▾ Month ▾

New Measure September 2014. Percentage of clean and clean-contaminated surgical patients who, prior to or at the time of discharge, showed evidence of a surgical site infection. These patients are a subgroup of the overall surgical site infection rate at 30 and 31 to 90 days post-operative.

Denominator

1 **What is the total number of clean and clean-contaminated surgical patients discharged for this reporting period?**

Numerator

2 **What is the total number of clean and clean-contaminated surgical patients sampled with Evidence of Surgical Site Infection at the Time of or Prior to Discharge for this reporting period?**

Your Result

3 Numerator/Denominator x 100 = %

Your Result

Goal 50% reduction

13.0 Per cent of Clean and Clean Contaminated Surgery Patients with Evidence of Surgical Site Infection Prior to Discharge - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
Percentage of clean and clean-contaminated surgical patients who, prior to or at the time of discharge, showed evidence of a surgical site infection. These patients are a subgroup of the overall surgical site infection rate at 30 and 31 to 90 days post-operative

Standard Goal: 95% or higher

Note: Reduce the Per cent of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to discharge by 10% every year

CALCULATION DETAILS:

Numerator Definition: Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge for this reporting period

Numerator Exclusions: Same exclusions as for denominator

Denominator Definition: Number of clean and clean-contaminated surgical patients discharged for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 13 (*numerator)

- *Yes
- No
- Unknown

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients with evidence of SSI prior to or at the time of discharge*

Comments:

- Determining whether a patient has a pre-existing infectious process at the surgical site or the wound class is generally easy to identify through review of the patient record. Some institutions or regions collect wound classes electronically.Antibiotic selected for each procedure should provide coverage for the majority of organisms likely to be encountered during the procedure but it does not need to eradicate every potential pathogen to be effective.

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

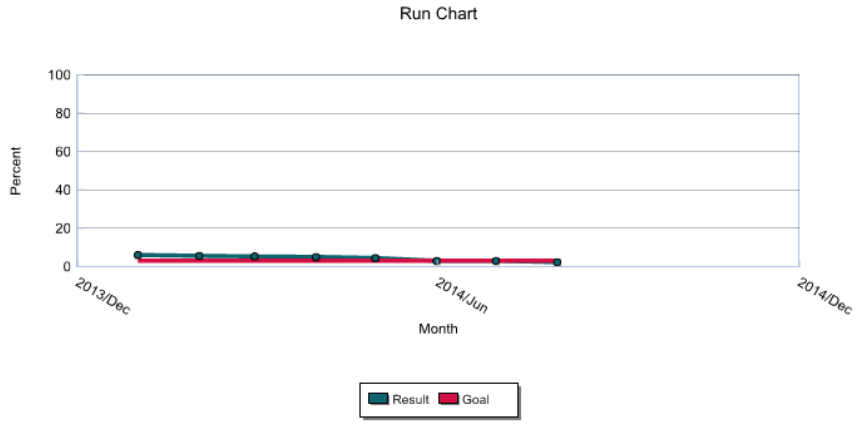
Sample Run Chart:

SSI 13 - Percent of Clean and Clean Contaminated Surgery Patients with Evidence of Surgical Site Infection at the Time of or Prior to Discharge

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 8 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/Aug	90	2	2.22%	
2014/Jul	100	3	3.00%	
2014/Jun	100	3	3.00%	
2014/May	90	4	4.44%	
2014/Apr	100	5	5.00%	
2014/Mar	95	5	5.26%	
2014/Feb	90	5	5.56%	
2014/Jan	100	6	6.00%	

14.0 Surgical Site Infection Pre-operative (Pre-op) Score - Sample Measurement Worksheet

SSI 14 - Surgical Site Infection Pre-operative (Pre-op) Score (In Patient, Adult)

Year [ ] Month [ ]

The overall average urgical Site Infection Pre-operative (Pre-op) Score, expressed as a percentage. This measure is automatically populated from questions C, D, and I in the Surgical Site Infection Data Collection (Audit) Form.

Denominator

1 **What is the total number of patients for whom a Surgical Site Infection Score was recorded for this reporting period?** [ ]

Numerator

2 **What is the total number of patients for whom all 3 Surgical Site Infection Pre-operative (Pre-op) elements were met for this reporting period?** [ ]

Numerator for Compliance with Surgical Site Infection Pre-operative (Pre-op) bundle elements (individual and overall)

3 Enter the total number of patients that were in compliance with **(C) Pre-op shower or bath with soap or antiseptic agent** this reporting period. [ ]

4 Enter the total number of patients that were in compliance with **(D) Solution used for intra-operative intact skin cleansing** this reporting period. [ ]

5 Enter the total number of patients that were in compliance with **(I) Hair Removal Method** this reporting period. [ ]

Your Result

6 Numerator/Denominator x 100 = % Your Result [ ]

Goal 100%

14.0 Surgical Site Infection Pre-operative (Pre-op) Score - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The overall average surgical Site Infection Pre-operative (Pre-op) Score, expressed as a percentage. This measure is automatically populated from questions C, D, and I in the Surgical Site Infection Data Collection (Audit) Form.

Standard Goal: 95% or higher

Note: Reduce the Per cent of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to discharge by 10% every year

CALCULATION DETAILS:

Numerator Definition: Number of patients for whom all 3 Surgical Site Infection Pre-operative (Pre-op) elements were met for this reporting period

Numerator Exclusions: Same exclusions as for denominator

Denominator Definition: Number of patients for whom a Surgical Site Infection Score was recorded for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 14 (*numerator)

- *Yes
- No
- Unknown

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients with evidence of SSI prior to or at the time of discharge*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

Sample Run Chart:

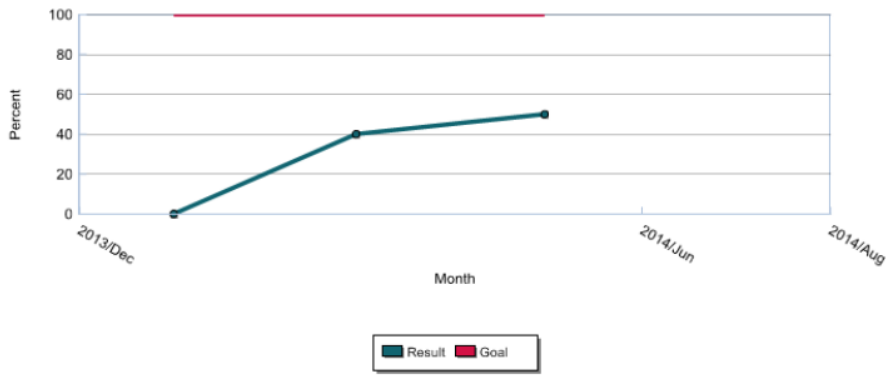
SSI 14 - Surgical Site Infection Pre-operative (Pre-op) Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.

Run Chart



Report Return: 3 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/May	4	2	50.00%	
2014/Mar	5	2	40.00%	
2014/Jan	4	0	0%	

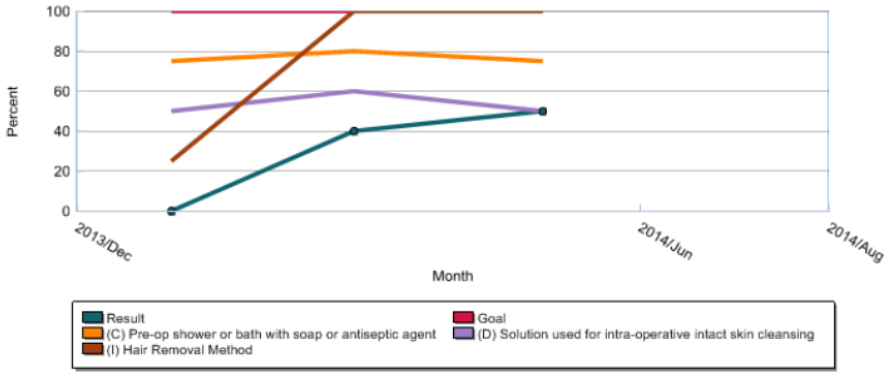
SSI 14 - Surgical Site Infection Pre-operative (Pre-op) Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.

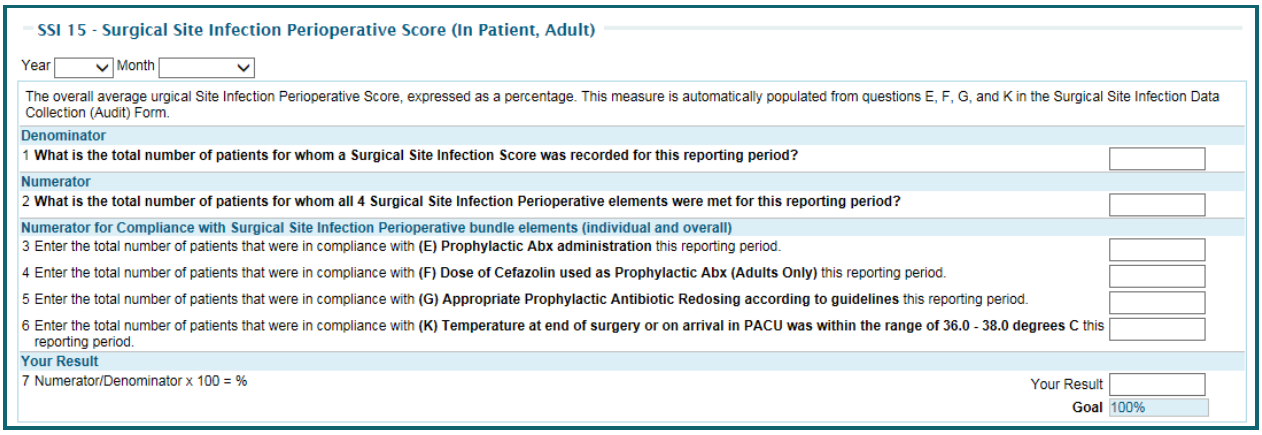
Run Chart



Report Return: 3 record(s)

Month	Numerator	Denominator	Result	(C) Pre-op shower or bath with soap or antiseptic agent	(D) Solution used for intra-operative intact skin cleansing	(I) Hair Removal Method
2014/May	2	4	50.00%	75%	50%	100%
2014/Mar	2	5	40.00%	80%	60%	100%
2014/Jan	0	4	0%	75%	50%	25%

15.0 Surgical Site Infection Perioperative Score - Sample Measurement Worksheet



SSI 15 - Surgical Site Infection Perioperative Score (In Patient, Adult)

Year [ ] Month [ ]

The overall average urgical Site Infection Perioperative Score, expressed as a percentage. This measure is automatically populated from questions E, F, G, and K in the Surgical Site Infection Data Collection (Audit) Form.

Denominator

1 **What is the total number of patients for whom a Surgical Site Infection Score was recorded for this reporting period?**

Numerator

2 **What is the total number of patients for whom all 4 Surgical Site Infection Perioperative elements were met for this reporting period?**

Numerator for Compliance with Surgical Site Infection Perioperative bundle elements (individual and overall)

3 Enter the total number of patients that were in compliance with **(E) Prophylactic Abx administration** this reporting period.

4 Enter the total number of patients that were in compliance with **(F) Dose of Cefazolin used as Prophylactic Abx (Adults Only)** this reporting period.

5 Enter the total number of patients that were in compliance with **(G) Appropriate Prophylactic Antibiotic Redosing according to guidelines** this reporting period.

6 Enter the total number of patients that were in compliance with **(K) Temperature at end of surgery or on arrival in PACU was within the range of 36.0 - 38.0 degrees C** this reporting period.

Your Result

7 Numerator/Denominator x 100 = %

Your Result

Goal 100%

15.0 Surgical Site Infection Perioperative Score - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The overall average surgical Site Infection Perioperative Score, expressed as a percentage. This measure is automatically populated from questions E, F, G, and K in the Surgical Site Infection Data Collection (Audit) Form.

Standard Goal: 95% or higher

Note: Reduce the Per cent of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to discharge by 10% every year

CALCULATION DETAILS:

Numerator Definition: Number of patients for whom all 4 Surgical Site Infection Pre-operative (Pre-op) elements were met for this reporting period

Numerator Exclusions: Same exclusions as for denominator

Denominator Definition: Number of patients for whom a Surgical Site Infection Score was recorded for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 15 (*numerator)

- *Yes
- No
- Unknown

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients with evidence of SSI prior to or at the time of discharge*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

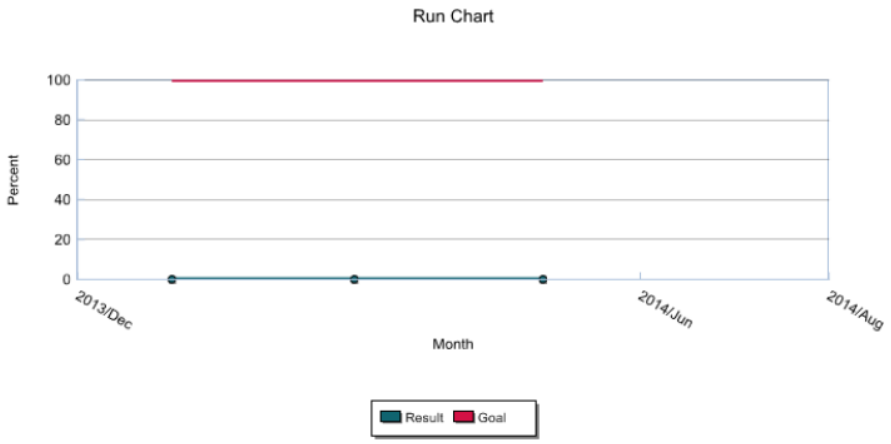
Sample Run Chart:

SSI 15 - Surgical Site Infection Perioperative Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 3 record(s)

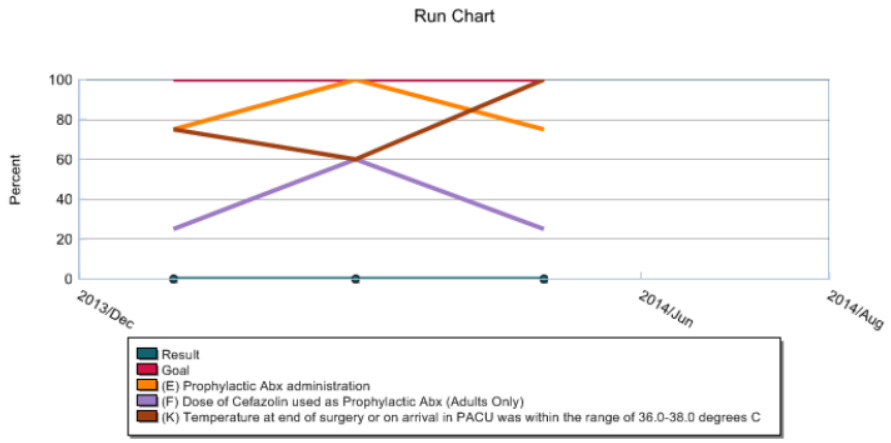
Month	Denominator	Numerator	Result	Comments and Good Catches
2014/May	4	0	0%	
2014/Mar	5	0	0%	
2014/Jan	4	0	0%	

SSI 15 - Surgical Site Infection Perioperative Score

In Patient, Adult

Export To CSV | Back

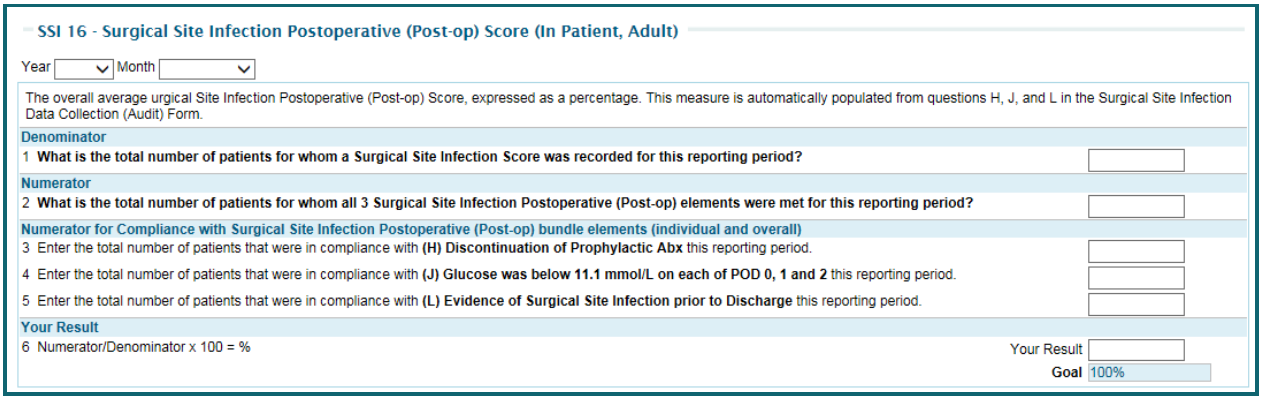
Note: Exports data table only.



Report Return: 3 record(s)

Month	Numerator	Denominator	Result	(E) Prophylactic Abx administration	(F) Dose of Cefazolin used as Prophylactic Abx (Adults Only)	(G) Appropriate Prophylactic Antibiotic Redosing according to guidelines	(K) Temperature at end of surgery or on arrival in PACU was within the range of 36.0-38.0 degrees C
2014/May	0	4	0%	75%	25%		100%
2014/Mar	0	5	0%	100%	60%		60%
2014/Jan	0	4	0%	75%	25%	25%	75%

16.0 Surgical Site Infection Postoperative (Post-op) Score- Sample Measurement Worksheet



SSI 16 - Surgical Site Infection Postoperative (Post-op) Score (In Patient, Adult)

Year [ ] Month [ ]

The overall average urgical Site Infection Postoperative (Post-op) Score, expressed as a percentage. This measure is automatically populated from questions H, J, and L in the Surgical Site Infection Data Collection (Audit) Form.

Denominator

1 **What is the total number of patients for whom a Surgical Site Infection Score was recorded for this reporting period?**

Numerator

2 **What is the total number of patients for whom all 3 Surgical Site Infection Postoperative (Post-op) elements were met for this reporting period?**

Numerator for Compliance with Surgical Site Infection Postoperative (Post-op) bundle elements (individual and overall)

3 Enter the total number of patients that were in compliance with **(H) Discontinuation of Prophylactic Abx** this reporting period.

4 Enter the total number of patients that were in compliance with **(J) Glucose was below 11.1 mmol/L on each of POD 0, 1 and 2** this reporting period.

5 Enter the total number of patients that were in compliance with **(L) Evidence of Surgical Site Infection prior to Discharge** this reporting period.

Your Result

6 Numerator/Denominator x 100 = %

Your Result

Goal 100%

16.0 Surgical Site Infection Postoperative (Post-op) Score - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The overall average surgical Site Infection Postoperative (Post-op) Score, expressed as a percentage. This measure is automatically populated from questions H, J, and L in the Surgical Site Infection Data Collection (Audit) Form.

Standard Goal: 95% or higher

Note: Reduce the Per cent of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to discharge by 10% every year

CALCULATION DETAILS:

Numerator Definition: Number of patients for whom all 3 Surgical Site Infection Post-operative (Post-op) elements were met for this reporting period

Numerator Exclusions: Same exclusions as for denominator

Denominator Definition: Number of patients for whom a Surgical Site Infection Score was recorded for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D**)

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 16 (*numerator)

- *Yes
- No
- Unknown

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation: Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients with evidence of SSI prior to or at the time of discharge*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

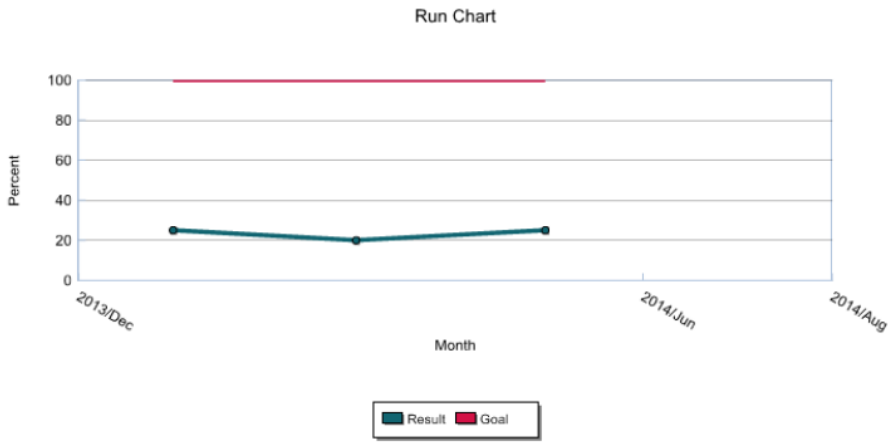
Sample Run Chart:

SSI 16 - Surgical Site Infection Postoperative (Post-op) Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 3 record(s)

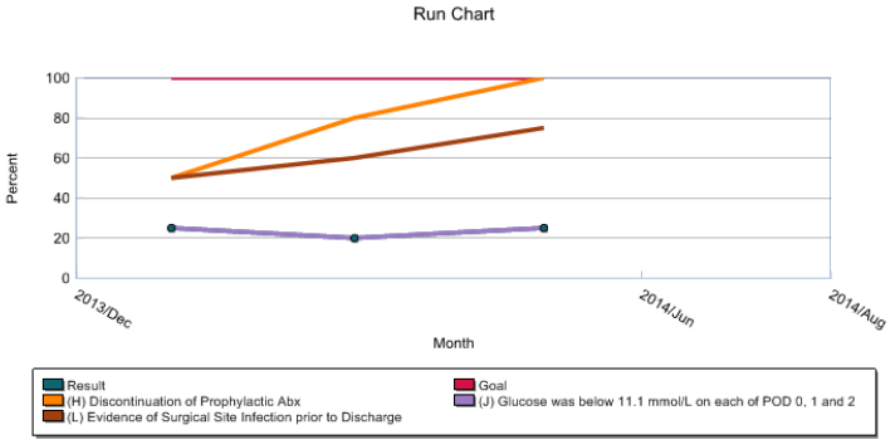
Month	Denominator	Numerator	Result	Comments and Good Catches
2014/May	4	1	25.00%	
2014/Mar	5	1	20.00%	
2014/Jan	4	1	25.00%	

SSI 16 - Surgical Site Infection Postoperative (Post-op) Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 3 record(s)

Month	Numerator	Denominator	Result	(H) Discontinuation of Prophylactic Abx	(J) Glucose was below 11.1 mmol/L on each of POD 0, 1 and 2	(L) Evidence of Surgical Site Infection prior to Discharge
2014/May	1	4	25.00%	100%	25%	75%
2014/Mar	1	5	20.00%	80%	20%	60%
2014/Jan	1	4	25.00%	50%	25%	50%

17.0 Surgical Site Infection Score - Sample Measurement Worksheet

SSI 17 - Surgical Site Infection Score (In Patient, Adult)

Year [ ] Month [ ]

The overall average urgical Site Infection Score, expressed as a percentage. This measure is automatically populated from questions C-L in the Surgical Site Infection Data Collection (Audit) Form.

Denominator	
1 **What is the total number of patients for whom a Surgical Site Infection Score was recorded for this reporting period?**	
Numerator	
2 **What is the total number of patients for whom all 10 Surgical Site Infection elements were met for this reporting period?**	
Numerator for Compliance with Surgical Site Infection bundle elements (individual and overall)	
3 Enter the total number of patients that were in compliance with **(C) Pre-op shower or bath with soap or antiseptic agent** this reporting period.	
4 Enter the total number of patients that were in compliance with **(D) Solution used for intra-operative intact skin cleansing** this reporting period.	
5 Enter the total number of patients that were in compliance with **(E) Prophylactic Abx administration** this reporting period.	
6 Enter the total number of patients that were in compliance with **(F) Dose of Cefazolin used as Prophylactic Abx (Adults Only)** this reporting period.	
7 Enter the total number of patients that were in compliance with **(G) Appropriate Prophylactic Antibiotic Redosing according to guidelines** this reporting period.	
8 Enter the total number of patients that were in compliance with **(H) Discontinuation of Prophylactic Abx** this reporting period.	
9 Enter the total number of patients that were in compliance with **(I) Hair Removal Method** this reporting period.	
10 Enter the total number of patients that were in compliance with **(J) Glucose was below 11.1 mmol/L on each of POD 0, 1 and 2** this reporting period.	
11 Enter the total number of patients that were in compliance with **(K) Temperature at end of surgery or on arrival in PACU was within the range of 36.0 - 38.0 degrees C** this reporting period.	
12 Enter the total number of patients that were in compliance with **(L) Evidence of Surgical Site Infection prior to Discharge** this reporting period.	
Your Result	
13 Numerator/Denominator x 100 = %	Your Result
	Goal 100%

17.0 Surgical Site Infection Score - Technical Description

Intervention(s): Reducing Surgical Site Infection

Definition: ***New Measure September 2014***
The overall average Surgical Site Infection Score, expressed as a percentage. This measure is automatically populated from questions C-L in the Surgical Site Infection Data Collection (Audit) Form.

Standard Goal: 95% or higher

Note: Reduce the Per cent of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to discharge by 10% every year

CALCULATION DETAILS:

Numerator Definition: Number of patients for whom all 10 Surgical Site Infection elements were met for this reporting period

Numerator Exclusions: Same exclusions as for denominator

Denominator Definition: Number of patients for whom a Surgical Site Infection Score was recorded for this reporting period

Denominator Exclusions:

- Patients less than 18 years of age
- Patients with an existing infectious process at the same site as the planned surgical procedure or surgeries that are classified under wound class three (Contaminated) or four (Dirty/Infected) (National Healthcare Safety Network (NHSN), see **Appendix D)**

Compliance Bundle: The data collected for this indicator is available for the individual responses and presented as a Compliance Run Chart with the performance for each response category displayed separately. The data are also available in tabular format.

Bundle Elements include:

- 1 gram
- 2 grams
- 3 grams

Data Collection (Audit) Form: The data collection form (DCF) is a paper-based tool formatted using optical mark recognition technology. The auditor may collect data specific to each of the Surgical Site Infection measures for one or more patients and fax the data form directly to the Patient Safety Metrics System. The form is read by the system and data are uploaded into specific individual measures. Results, tabular and run charts, may be accessed within 30 minutes of faxing the form

DCF Response Options – SSI 17 (*numerator)

- *Yes
- No

- Unknown

Measurement Period: Monthly

Calculate as: (numerator / denominator); as a percentage

Example of the Calculation:		
Number of clean and clean-contaminated surgical patients with evidence of surgical site infection prior to or at the time of discharge --- Total no. of Clean and Clean-contaminated surgical patients in this reporting period	**X 100 =**	*Per cent of* Clean and Clean-Contaminated *Surgical Patients with evidence of SSI prior to or at the time of discharge*

COLLECTION STRATEGY:

Safer Healthcare Now! recommends that teams complete concurrent or "real time" data collection as much as possible. The ability to sustain data collection is higher if you integrate data collection into day-to-day work. However, if a team decides to collect their data using retrospective chart reviews then a hospital information system may be able to identify the patients from all discharges by sorting based on these elements. Another alternative is to work with the coding or medical records department to identify the patients at the time of coding and prepare a list or set aside records for review.

SAMPLING STRATEGY:

Safer Healthcare Now! recommends that you start with one surgical procedure (i.e., hip arthroplasty) and spread to other surgical procedures over time.

Hospitals may decide to collect data using sampling if there is a sufficient volume of cases. The sample size (n) based on the surgical patient population size (N):

Average Monthly Population Size *"N"*	Minimum required sample *"n"*
< 20	No sampling; 100% of population required
20 – 100	20
> 100	15 - 20% of population size

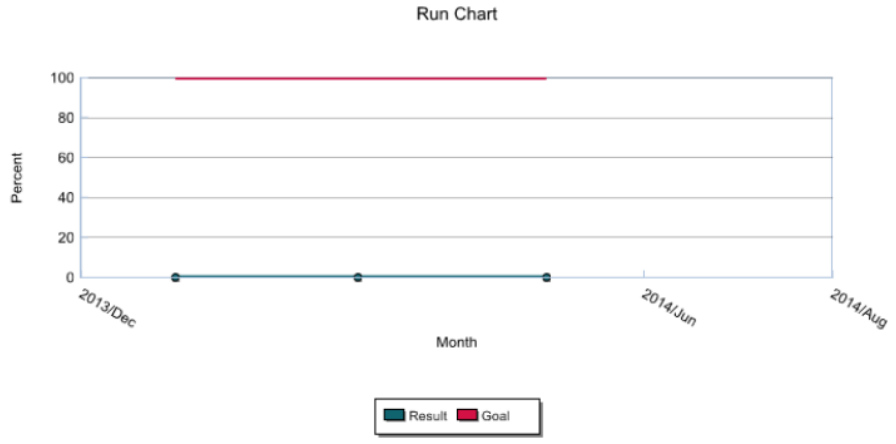
Sample Run Chart:

SSI 17 - Surgical Site Infection Score

In Patient, Adult

Export To CSV | Back

Note: Exports data table only.



Report Return: 3 record(s)

Month	Denominator	Numerator	Result	Comments and Good Catches
2014/May	4	0	0%	
2014/Mar	5	0	0%	
2014/Jan	4	0	0%	

Appendix D: National Healthcare Safety Network (NHSN) Definition of Wound Classifications**

Class I - Clean	An Uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is 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.
Class II – Clean-Contaminated	An operative wound 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.
Class III - 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 are included in this category.
Class IV Dirty-Infected	Old traumatic wounds with retained devitalized 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.

** Mangram et al. (1999). Guideline for Prevention of Surgical Site Infection. *Infection Control and Hospital Epidemiology, 20*(4), p. 247-278. http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/SSI.pdf

References

1 Cataife G, Weinberg DA, Wong HH, et al. The effect of Surgical Care Improvement Project (SCIP) compliance on surgical site infection (SSI). Med Care 2014;52(suppl1):S66-73.

2 Auerbach A. Prevention of surgical site infections. In: Shojania K, Duncan B, McDonnald K, et al, eds. Making Health Care Safer: A critical Analysis of Patient Safety Practices Evidence report/technology assessment no 43. Rockville, MD: Agency for Healthcare Research and Quality; 2001:221-44.

3 Kirkland K, Briggs J, Trivette S, Wilkinson W, Sexton D. The impact of surgical-site infections on the 1990s: Attributable mortality, excess length of hospitalization, and extra costs. Infect Control Hosp Epidemiol 1999;20:725-30.

4 Martone W, Nichols R. Recognition, prevention, surveillance, and management of surgical site infections: Introduction to the problem and symposium overview. Clinical infectious Diseases 2001;33:S67-8.

5 Abramowicz M. Antimicrobial prophylaxis in surgery. The Medical Letter on Drugs and Therapeutics 2001;43:W1116-7.

6 Buckley, Hughes, Snodgrass, Hunchcroft. Perioperative cefazolin prophylaxis in hip fracture surgery. Can J Surg 1990;33:122-7.

7 D'Angelo G, Ogilvie-Harris. Septc arthritis following arthroscopy, with cost/benefit analysis of antibiotic prophylaxis. J Arthroscopy 1988;4:10-4.

8 Eason E, Wells G, Garber G, Hopkins M. Antisepsis for abdominal hysterectomy: A randomized controlled trial of povidone-iodine gel. Obstet Gynaecol Can 2004;26:1067-72.

9 Ferraz A, Ferraz E. Antibioticoprofiaxia em cirurgia. In: Editora D, ed. Programa de atualizac a o em uso de antibio'ticos em cirurgia. Rio de Janeiro, Brazil; 2002.

10 Labbe A, Demers A, Rodrigues R, Arlet V, Tanguay K, Moore D. Surgical-site infection following spinal fusion: A case-control study in a children's hospital. Infect Control Hosp Epidemiol 2003;243:591-5.

11 Polk H, Christmas B. Prophylactic antibiotics in surgery and surgical wound infections. Am Surg 2000;66:105-11.

12 Waddell T, Rotstein O. Antimicrobial prophylaxis in surgery:Committee on antimicrobial agents, Canadian Infectious Diseases Society. CMAJ 1994;151:925-31.

13 Weed H. Antimicrobial prophylaxis in the surgical patient. Med Clin North Am 2003;87:59-75.

14 Wong E. Surgical Site Infections. In: Mayhall C, ed. Hospital Epidemiology and Infection Control. Philadelphia: Lippincott, Williams & Wilkins; 1999.

15 Zoutman D, Chau L, Watterson J, Mackenzie T, Djurfeldt M. A Canadian survey of prophylactic antibiotic use among hip fracture patients. Infect Control Hosp Epidemiol 1999;20:752-5.

16 Glyssens I. Preventing postoperative infections:current treatment recommendations. Drugs 1999;57:175-85.

[17] Galway U, Parker B, Borkowski R. Prevention of postoperative surgical site infections. International Anesthesiology Cinics 2009;47:37-53.

[18] Zvonar RK, et al. Practice changes to improve delivery of surgical antibiotic prophylaxis. Healthc Q 2008;11:141-4.

[19] Thirion DJG, et al. Évaluation de l'implantation d'un guide de pratique en antibioprophylaxie chirurgical (projet Évidance). Pharmactuel 2009;42(suppl. 2) :41-52.)

[20] Thirion DJG. Chap 61: Antimicrobial Prophylaxis for Surgical Procedures.

[21] Koda-Kimble MA, Young LY, Alddredge BK, et al. Applied Therapeutics: The Clinical use of Drugs. 10th ed. Philadelphia, Lippincott Williams & Wilkins 2012;1461-1467

[22] Surveillance of Surgical Site Infections in European Hospitals – HAISSI Protocol. European Centre for Disease Prevention and Control version 10.2 2012; 1-39.

[23] Bratzler DW, Dellinger P, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health-Syst Pharm. 2013;70:195-283.

[24] DiPiro JT, Vallner JJ, Bowden TA, Clark BA, Sisley JF. Intraoperative serum and tissue activity of cefazolin and cefoxitin. Arch Surg 1985; 120:829–32.

[25] Kanter G, Connelly NR, Fitzgerald J. A System and Process Redesign to Improve Perioperative Administration. Anesth Analg 2006;103:1517-21.

[26] Anderson D, Kaye K, Classen D, et al. SHEA/IDSA Practice Recommendations: Strategies to prevent surgical site infections in acute care hospitals. Infection Control and Hospital Epidemiology 2008;29:S51-S61.

[27] Tita A, Rouse D, Blackwell S, Saade G, Soponge C, Andrews W. Emerging concepts in antibiotic prophylaxis for cesarean delivery: A systematic review. Obstetrics & Gynecology 2009;113:675-82.

[28] Smaill F, Gyte G. Antibiotic prophylaxis versus no prophylaxis for preventing infection after cesarean section (Review). Cochrane Database Systematic Review 2010;CD007482.

[29] Ward V, Charlett A, Fagan J, Crawshaw S. Enhanced surgical site infection surveillance following caesarean section: Experience of a multicentre collaborative post-discharge system. Journal of Hospital Infection 2008;70:166-73.

[30] Opøien H, Valbø A, Grinde-Andersen A, Walberg M. Post-cesarean surgical site infections according to CDC standards: rates and risk factors. A prospective cohort study. Acta Obstetricia et Gynecologica 2007;86:1097-102.

[31] Costantine M, Mahbubur R, Ghulmiyah L, et al. Timing of perioperative antibiotics for cesarean delivery: A metaanalysis. American Journal of Obstetrics & Gynecology 2008;199:e1-e6.

[32] Sullivan S, Smith T, Chang E, Hulsey T, Vandorsten P, Soper D. Administration of cefazolin prior to skin incision is superior to cefazolin at cord clamping in preventing postcesarean infectious morbidity: a randomized, controlled trial. American Journal of Obstetrics & Gynecology; 2007:e1-e5.

[33] Thigpen B, Hood W, Chauhan S, et al. Timing of prophylactic antibiotic administratoin in the uninfected laboring gravida: A randomized clinical trial. American Journal of Obstetrics & Gynecology 2005;192:1864-71.

[34] NICE. National Collaborating Centre for Women's and Children's Health - NHS/NICE Guideline. Surgical site infection: Prevention and treatment of surgical site infection. In: NICE; 2008.

[35] Kaimal A, Zlatnik M, Cheng Y, et al. Effect of a change in policy regarding the timing of prophylactic antibiotics on the rate of postcesarean delivery surgical-site infections. American Journal of Obstetrics and Gynecology 2008;199:310.e1-.e5.

[36] Scottish Intercollegiate Guidelines Network. Antibiotic Prophylaxis is Surgery: A National Clinical Guideline. Edinburgh: Scottish Intercollegiate Guideline Network; 2008.

[37] WHO. The WHO Guidelines for Safe Surgery. In: WHO, ed. 1st ed. Geneva: WHO; 2008.

[38] Friedman RJ, Friedrich LV, White RL, Kays MB, Brundage DM, Graham J. Antibiotic prophylaxis and tournique inflation in total knee arthroplasty. Clin Orthop Relat Res 1990;260:17-23.

[39] Johnson S, Gerding D. *Clostridium-difficile*-associated diarrhea. Clin Infect Dis 1998;26:1027-36.

[40] Abdel-Salam A, Yeyres K. Effects of tourniquet during total knee arthroplasty. A prospective randomised study. Journal of Bone and Joint Surgery 1995;77B:250-3.

[41] Barwell J, Anderson G, Hassan A, Rawlings I. The effects of early tourniquet release during total knee arthroplasty. J Bone Joint Surg 1997;79B:265-8.

[42] Edmiston C, Krepel C, Kelly H, et al. Perioperative antibiotic prophylaxis in the gastric bypass patient: Do we achieve therapeutic levels? Surgery 2004;136:738-47.

[43] Forse R, Karam B, Maclean D, Christou N. Antibiotic prophylaxis for surgery in morbidly obese patients. Surgery 1989;106:750-7.

[44] Zelenitsky SA, Ariano RE, Harding GKM, et al. Antibiotic pharmacodynamics in surgical prophylaxis: an association between intraoperative antibiotic concentrations and efficacy. Antimicrob Agents Chemother 2002;46:3026-30.

[45] Zelenitsky SA, Silverman RE, Duckworth H, et al. A prospective, randomized, double-blind study of single high dose versus multiple standard dose gentamicin both in combination with metronidazole for colorectal surgical prophylaxis. J Hospital Infection 2000;46:135-40.

[46] Pai M, Bearden D. Antimicrobial dosing considerations in obese adult patients: Insights from the Society of Infectious Diseases Pharmacists. Pharmacotherapy 2007;27:1081-91.

[47] Ho VP, Nicolau DP, Dakin GF, et al. Cefazolin dosing for surgical prophylaxis in morbidly obese patients. Surg Infect 2012;13:33-7.

[48] Baqain Z, Hyde N, Patrikidou A, Harris M. Antibiotic prophylaxis for orthognathic surgery: a prospective, randomized clinical trial . British Journal of Oral & Maxillofacial Surgery 2004;42:506-10.

[49] DiPiro J, Cheung R, Bowden T, Mansberger J. Single dose systematic antibiotic prophylaxis of surgical wound infections. Am J Surg 1986;152:552-9.

[50] McDonald M, Grabsch E, Marshall C, Forbes A. Single-versus multiple-dose antimicrobial prophylaxis for major surgery: a systematic review. Aust NZ J Surg 1998;68:388-96.

[51] Song F, Glenny A. Antimicrobial prophylaxis in colorectal surgery: A systematic review of randomized controlled trials. Br J Surg 1998;85:1232-41.

[52] Fridrich K, Partnoy B, Zeitler D. Prospective analysis of antibiotic prophylaxis for orthognathic surgery. International Journal of Adult Orthodontics & Orthognathic Surgery 1994;9:129-31.

[53] Andrews P, East C, Jayaraj S, Badia L, Panagamuwa C, Harding L. Prophylactic vs postoperative antibiotic use in complex septorhinoplasty surgery: a prospective, randomized, single-blind trial comparing efficacy. Archives of Facial Plastic Surgery 2006;8:84-7.

[54] Coskun H, Erisen L, Basut O. Factors affecting wound infection rates in head and neck surgery. Otolaryngology Head & Neck Surgery 2000;123:328-33.

[55] Ahmadi A, Cohen B, Shayani P. A prospective study of antibiotic efficacy in preventing infection in reduction mammoplasty. Plastic & Reconstructive Surgery 2005;116:126-31.

[56] Zanetti G, Giardina R, Platt R. Intraoperative redosing of cefazolin and risk for surgical site infection in cardiac surgery. Emerging Infectious Diseases 2001;7:813-7.

[57] Smaill F, Hofmeyr G. Antibiotic prophylaxis for cesarean section. Cochrane Database Systematic Review 2002;3.

[58] Takahashi S, Takeyama K, Miyamoto S, Tanuma Y, Takagi Y. Surgical antimicrobial prophylaxis in transurethral ureterolithotripsy. Journal of Infection & Chemotherapy 2005;11:239-43.

[59] The Medical Letter. Treatment guidelines from The Medical Letter: Antimicrobial prophylaxis for surgery. The Medical Letter 2012; 10(122):73-78.

[60] ASCRS. Perioperative management. In. 2005 ed: The American Society of Colon and Rectal Surgeons 2005.

[61] Bratzler D, Houck P. Antimicrobial prophylaxis for surgery: An advisory statement from the National Surgical Infection prevention Project. Clinical infectious Diseases 2004;38:1706-15.

[62] Harbarth S, et al. Prolonged antibiotic prophylaxis after cardiovascular surgery and its effect on surgical site infections and antimicrobial resistance. Circulation 2000;101:2916-21.

[63] Hecker MT, Aron DC, Patel NP, Lehmann MK, Donskey CJ. Unnecessary use of antimicrobials in hospitalized patients: current patterns of misuse with an emphasis on the antianaerobic spectrum of activity. Arch Intern Med 2003;163:972-8.

[64] Kyne L, Hamel M, Polavarm R, Kelly C. Health care costs and mortality associated with nosocomial diarrhea due to *Clostridium-difficile*. Clin Infect Dis 2002;34:346-53.

[65] Nishimura RA, Carabello BA, Faxon DP, et al. ACC/AHA 2008 Guideline Update on Valvular Heart Disease: Focused Update on Infective Endocarditis: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines Endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *J Am Coll Cardiol.* 2008;52(8):676-685. doi:10.1016/j.jacc.2008.05.008.

[66] van der Boon RMA, Nuis R-J, Benitez LM, et al. Frequency, determinants and prognostic implications of infectious complications after transcatheter aortic valve implantation. Am J Cardiol 2013;112:104–10.

[67] Bertaglia E, Zerbo F, Zardo S, Barzan D, Zoppo F, Pascotto P. Antibiotic prophylaxis with a single dose of cefazolin during pacemaker implantation: incidence of long-term infective complications. Pacing Clin Electrophysiol 2006;29: 29-33.

[68] Smith BP, Fox N, Fakhro A. "SCIP"ping antibiotic prophylaxis guidelines in trauma: the consequences of noncompliance. J Trauma Acute Care Surg 2012; 73(2): 452–6; discussion 456.

[69] Trampuz A, Zimmerli W. Antimicrobial agents in orthopaedic surgery: prophylaxis and treatment. Drugs. 2006;66:1089–105.

[70] Fletcher N, D'Mitri B, Marschall BO, et al. Prevention of perioperative infection. J Bone Joint Surg Am. 2007;89:1605–18.

[71] Gurkan I, Wenz JF. Perioperative infection control: an update for patient safety in orthopedic surgery. Orthopedics. 2006;29:329–39.

[72] Bratzler DW, Houck PM. Antimicrobial prophylaxis for surgery: an advisory statement from the National Surgical Infection Prevention Project. Am J Surg. 2005;189:395–404.

[73] von Eiff C, et al. Nasal carriage as a source of Staphylococcus aureus bacteremia. Study Group. New England Journal of Medicine 2001;344:11-6.

[74] AORN. Recommended practices for perioperative patient skin antisepsis. Denver, CO: AORN; 2013.

[75] Hebl J. The importance and inplications of aseptic techniques during regional anesthesia. Regional Anesthesia and Pain Medicine 2006;31:311-23.

[76] Paocharoen V, Mingmalairak C, Apisarnthanarak A. Comparison of surgical wound infection after pre-operative skin preparation with/ 4% CHG & povidone Iodine. J Med Assoc Thai 2009;92:898-902.

[77] Saltzman M, Nuber G, Gryzlo S, Maracek G, Koh J. Efficacy of surgical preparation solutions in shoulder surgery. J Bone Joint Surg Am 2009;91:1949-53.

[78] Darouiche R, Wall M, Itani K, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. The New England Journal of Medicine 2010;362:18-26.

[79] Adams D, Quayum M, Worthington T, Lambert P, Elliott T. Evaluation of a 2% chlorhexidine gluconate in 70% isopropyl alcohol skin disinfectant. Journal of Hospital Infection 2005;61:287-90.

[80] Fletcher N, Sofianos D, Berkes M, Obremskey W. Prevention of perioperative infection. J Bone Joint Surg Am 2007;89:1605-18.

[81] Denton GW. Chlorhexidine. In: Lippincott WW, Block SS, ed Disinfection, sterilization, and preservation. 5th Edition ed. Philadelphia; 2001:321-36.

[82] Milstone A, Passaretti C, Perl T. Chlorhexidine: Expanding the armamentarium for infection control and prevention Clin Infect Dis 2007;46:274-81.

[83] Darouiche RO, Wall MJ Jr, Itani KM, Otterson MF, Webb AL, Carrick MM *et al*. Chlorhexidine–alcohol *versus* povidone – iodine for surgical-site antisepsis. *N Engl J Med* 2010; **362**: 18–26.

[84] Saltzman MD, Nuber GW, Gryzlo SM, Marecek GS, Koh JL. Efficacy of surgical preparation solutions in shoulder surgery. J Bone Joint Surg Am. 2009;91(8):1949–1953.

[85] Bode LG, Kluytmans JA, Wertheim HF, et al. Preventing surgical-site infections in nasal carriers of Staphylococcus aureus. N Engl J Med 2010;362:9-17.

[86] Lim K, Kam P. Chlorhexidine - pharmacology and clinical applications. Anaesthesia and Intensive Care 2008;36:502-11.

[87] Yokoe D, Mermel L, Anderson D, et al. A compendium of strategies to prevent healthcare-associated infections in acute care hospitals. Infection Control and Hospital Epidemiology 2008;29:S12-S21.

[88] Over-the-Counter Topical Antiseptic Products: Drug Safety Communication - FDA Requests Label Changes and Single-Use Packaging to Decrease Risk of Infection. http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm374892.htm. FDA. Nov 13, 2013.

[89] Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Systematic Review 2006;2.

[90] Rotter ML, et al. A comparison of the effects of preoperative whole-body bathing with detergent alone and with detergent containing chlorhexidine gluconate on the frequency of wound infections after clean surgery. The European Working Party on Control of Hospital Infections. Journal of Hospital Infection 1988;11:310-20.

[91] Evans HL, Dellit TH, Chan J, Nathens AB, Maier RV, Cuschieri J. Effect of chlorhexidine whole-body bathing on hospital-acquired infections among trauma patients. Arch Surg 2010;145:240-6.

[92] Rauk P. Educational intervention, revised instrument sterilization methods, and comprehensive preoperative skin preparation protocol reduce cesarean section surgical site infections. AJIC 2010;38:319-23.

[93] Evans R. Acute anaphylaxis due to topical chlorhexidine acetate. British Medical Journal 1992;304:686.

[94] Tabor E, Bostwick DC, Evans CC. Corneal damage due to eye contact with chlorhexidine gluconate. Journal of the American Medical Association 1989;261:557-8.

[95] Bicknell PG. Sensorineural deafness following myringoplasty operations. J Laryngol Otol 1971;85.

[96] Drug Safety Labeling Changes. http://www.fda.gov/Safety/MedWatch/SafetyInformation/Safety-RelatedDrugLabelingChanges/ucm306941.htm. FDA. May 2012.

[97] Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. Infect Control Hosp Epidemiol 1999; 20: 725-730.

[98] Casewell MW. The nose: an underestimated source of Staphylococcus aureus causing wound infection. J Hosp Infect 1998; 4O (suppl B): S3- s11.

[99] Wenzel W, Per1 TM. The significance of nasal carriage of Staphylococcus aureus and the incidence of postoperative wound infection.] Hosp Infect 1995; 31: 13-24.

[100] Kallen AJ, Wilson CT, Larson RJ. Perioperative intranasal mupirocin for the prevention of surgical-site infections: systematic review of the literature and meta-analysis. Infect Control Hosp Epidemiol 2005;26:916-22.

[101] Rao N, Cannella B, Crossett LS, Yates AJ Jr, McGough R 3rd. A preoperative decolonization protocol for staphylococcus aureus prevents orthopaedic infections. Clin Orthop Relat Res. 2008; 466: 1343-8.

[102] Street CN, Pedigo L, Gibbs A, Loebel NG. Antimicrobial photodynamic therapy for the decolonization of methicillin-resistant Staphylococcus aureus from the anterior nares. Proc SPIE. 2009; 7380.

[103] Wilson M. Lethal photosensitisation of oral bacteria and its potential application in the photodynamic therapy of oral infections. Photochem Photobiol Sci 2004; 3: 412-418.

[104] Bryce E, Wong T, Roscoe D. Immediate Pre-operative Decolonization Therapy Reduces Surgical Site Infections. British Columbia Quality Forum. Vancouver, March 2013 [presentation].

[105] Moghissi K. Can surgical site infection (SSI) be treated by photodynamic therapy (PDT)? Photodiagnosis Photodyn Ther. 2010; 7: 1–2

[106] Hamblin MR, Dai T. Can surgical site infections be treated by photodynamic therapy? Photodiagnosis Photodyn Ther. 2010; 7: 134–6.

[107] Adisa AO, Lawal OO, Adejuyigbe O. Evaluation of two methods of preoperative hair removal and their relationship to postoperative wound infection. J Infection Dev Ctries 2011;5(10):717-22.

[108] Alexander JW, Fischer JE, Boyajian M, et al. The influence of hair-removal methods on wound infections. Arch Surg. 1983;118:347–352.

[109] Cruse P. Wound infection surveillance. Rev Infect Dis 1981;3:734-7.

[110] Seropian R, Reynolds B. Wound infection after preoperative depilatory versus razor preparation. Am J Surg 1971;121:251-4.

[111] Small S. Preoperative hair removal: a case report with implicaitons for nursing. Clin Nurs 1996;5:79-84.

[112] Tanner J and Khan D (2008) Surgical site infection, preoperative body washing and hair removal. J Perioper Pract 18:237-243.

[113] Sebastian S. Does preoperative scalp shaving result in fewer postoperative wound infections when compared with no scalp shaving? A systematic review. Journal of Neuroscience Nursing, 2012;44, (3): 149-56.

[114] Tokimura H, Tajutsu K, Tsuchiya M, Yamahata H, Taniguchi A, Takayama K, et al: Cranial surgery without head shaving. Journal of CranioMaxillofacial Surgery 37:477-480, 20.

[115] Kumar K, Thomas J, Chan C: Cosmesis in neurosurgery: is the bald head necessary to avoid postoperative infection? Ann Acad Med Singapore 2002; 31:150-154.

[116] Miller JJ, Weber PC, Patel S, Ramey J: Intracranial surgery: to shave or not to shave? Otology and Neurotology 2001; 22:908-911.

[117] Tang K, Yeh JS, Shouros S: The influence of hair shave on the infection rate in neurosurgery. . Paediatric Neurosurgery 2001;35:13-17.

[118] Braun V, Richter HP: Shaving the hair - is it always necessary for cranial neurosurgical procedures? Acta Neurochirugica 1995; 135:84-86.

[119] Kretschmer T, Braun V, Richter HP: Neurosurgery without shaving: indications and results. Br J Neurosurgery 2000; 14:341-344.

[120] Broekman ML, van Beijnum J, Peul WC, Regli L. Neurosurgery and shaving: what's the evidence? J Neurosurg 2011;115:670–8.

[121] Dellinger E. Preventing surgical-site infections: the importance of timing and glucose control. Infect Control Hosp Epidemiol 2001;22:604-6.

[122] Latham R, Lancaster A, Covington J, Pirolo J, Thomas CJ. The association of diabetes and glucose control with surgical-site infections among cardiothoracic surgery patients. Infect Control Hosp Epidemiol 2001;22.

[123] Presutti E, Millo J. Controlling blood glucose levels to reduce infection. Crit Care Nurs Q 2006;29:123-31.

[124] Umpierrez G, Isaacs S, Bazargan H, You X, Thaler L, Kitabchi A. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. J Clin Endocrinol Metab 2002;87:978-82.

[125] van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in the critically ill patients. New England Journal of Medicine 2001;345:1359-67.

[126] Wiener R, Wiener D, Larson R. Benefits and risks of tight glucose control in critically ill adults: a meta-analysis. JAMA 2008;300:933-44.

[127] Griesdale D, de Souza R, van Dam R, et al. Intensive insulin therapy and mortality among ciritically ill patients: a meta-analysis including NICESUGAR study data. CMAJ 2008;180:821-7.

[128] Brunkhorst F, Engel C, Bloos F, et al. Intensive insulin therapy and pentastarch resuscitation in severe sepsis. New England Journal of Medicine 2008;358:125-39.

[129] Finfer S, Chittock D, Su S, et al. Intensive versus conventional glucose control in critically ill patients. New England Journal of Medicine 2009;360:1283-97.

[130] Kao L, Meeks D, Moyer V, Lally K. Peri-operative glycaemic control regimens for preventing surgical site infections in adults. Cochrane Database Systematic Review 2009;CD006806:i-32.

[131] Moghissi E, Korytkowski M, DiNardo M, et al. American association of clinical endocrinologists and American diabetes association consensus statement on inpatient glycemic control. Endocrine Practice 2009;15:1-17.

[132] Young V, Watson M. Prevention of Perioperative Hypothermia in Plastic Surgery. Aesthetic Surgery Journal. 2006;551-571.

[133] Kurtz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. Study of Wound Infection and Temperature Group. N Engl J Med. 1996 May 9;334(19):1209-15.

[134] Melling A, Ali B, Scott E, Leaper D. Effects of preoperative warming on the incidence of wound infection after clean surgery: a randomised controlled trial. Lancet 2001;358:876-80.

[135] Rajagopalan, Suman M.D.; Mascha, Edward Ph.D.; Na, Jie M.S.; Sessler, Daniel I. M.D. The effects of mild perioperative hypothermia on blood loss and transfusion requirement. Anesthesiology. 2008 Jan;108(1):71-7.

[136] Frank SM1, Fleisher LA, Breslow MJ, Higgins MS, Olson KF, Kelly S, Beattie C. Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events. A randomized clinical trial. JAMA. 1997 Apr 9;277(14):1127-34.

[137] Forbes SS1, Eskicioglu C, Nathens AB, Fenech DS, Laflamme C, McLean RF, McLeod RS. Evidence-based guidelines for prevention of perioperative hypothermia. J Am Coll Surg. 2009 Oct;209(4):492-503.

[138] Standards, Guidelines and Position Statements for Perioperative Registered Nursing Practice. www.ornac.ca/standards. ORNAC, 10th Edition 2011;1-33.

[139] Horn EP, Bein B, Böhm R, Steinfath M, Sahili N, Höcker J. The effect of short time periods of pre-operative warming in the prevention of peri-operative hypothermia. Anaesthesia. 2012 Jun;67(6):612-7.

[140] Grigore AM1, Grocott HP, Mathew JP, Phillips-Bute B, Stanley TO, Butler A, Landolfo KP, Reves JG, Blumenthal JA, Newman MF. The rewarming rate and increased peak temperature alter neurocognitive outcome after cardiac surgery. Anesth Analg. 2002 Jan;94(1):4-10.

[141] Belway D, Tee R, Nathan HJ, Rubens FD, Boodhwani M. Temperature management and monitoring practices during adult cardiac surgery under cardiopulmonary bypass: results of a Canadian national survey. Perfusion. 2011 Sep;26(5):395-400.

[142] Nesher N, Wolf T, Kushnir I, David M, Bolotin G, Sharony R, Pizov R, Uretzky G. Novel thermoregulation system for enhancing cardiac function and hemodynamics during coronary artery bypass graft surgery. Ann Thorac Surg. 2001 Sep;72(3):S1069-76.

[143] Hohn L et al. Benefits of intraoperative skin surface warming in cardiac surgical patients. Br J Anaesth 1998;80:318-23.

[144] Hofer CK, Worn M, Tavakoli R, Sander L, Maloigne M, Klaghofer R, Zollinger A: Influence of body core temperature on blood loss and transfusion requirements during off-pump coronary artery bypass grafting: A comparison of 3 warming systems. J Thorac Cardiovasc Surg 2005; 129:838–43.

[145] Teodorczyk JE et. al. Effectiveness of an Underbody Forced Warm-Air Blanket during Coronary Artery Bypass Surgery in the Prevention of Postoperative Hypothermia: A Prospective Controlled Randomized Clinical Trial. OJAnes, Vol.2, No.3, July 2012.

[146] Chen YY, Wang FD, Liu CY, Chou P. Incidence rate and variable cost of nosocomial infections in different types of intensive care units. Infect Control Hosp Epidemiol 2009;30:39-46.

[147] Defez C, Fabbro-Peray P, Cazaban M, Boudemaghe T, Sotto A, Daures JP. Additional direct medical costs of nosocomial infections: an estimation from a cohort of patients in a French university hospital. J Hosp Infect 2008;68:130-6.

[148] Weber WP, Zwahlen M, Reck S, Feder-Mengus C, Widmer AF, Marti WR. Economic burden of surgical site infections at a European university hospital. Infect Control Hosp Epidemiol 2008;29(7):623-9.

[149] Whitehouse JD, Friedman D, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. Infect Control Hosp Epidemiol 2002;23(4):183-9.

[150] Mahmoud NN, Turpin RS, Yang G, Saunders WB. Impact of surgical site infections on length of stay and costs in selected colorectal procedures. Surg Infect 2009;10(6):539-44.

[151] Penel N, Lefebvre JL, Cazin JL, Clisant S, Neu JC, Dervaux B, et al. Additional direct medical costs associated with mosocomial infections after head and neck cancer surgery: a hosptial-perspective analysis. Int J Oral Maxillofac Surg 2008;37:135-9.

[152] Jenney AW, Harrington GA, Russo PL, Spelman DW. Cost of surgical site infections following coronary artery bypass surgery. ANZ Journal of Surgery 2001 Nov;71(11):662-4.

[153] Olsen MA, Butler AM, Willers DM, Gross GA, Hamilton BH, Fraser VJ. Attributable costs of surgical site infection and endometritis after low transverse cesarean delivery. Infect Control Hosp Epidemiol 2010;31(3):276-82.

[154] Kasatpibal N, Thongpiyapoom S, Narong MN, Suwalak N, Jamulitrat S. Extra charge and extra length of postoperative stay attributable to surgical site infection in six selected operations. J Med Assoc Thai 2005;88:1083-1091

[155] Weber WP, Zwahlen M, Reck S, feder-Mengus C, Widmer Af, Marti WR. Economic burden of surgical site infections at a European university hospital. Infect Control hosp Epidemiol 2008;29(7):623-9.

[156] Alfonso JL, Pereperez SB, Canoves JM, Martinez MM, Martinez IM, Martin-Moreno JM. Are we really seeing the total costs of surgical site infections? A Spanish study. Wound Repair Regen 2007;15:474e481.

[157] Coello R, Charlett A, Wilson J, Ward V, Pearson A, Borriello P. Adverse impact of surgical site infections in English hospitals. J Hosp Infect 2005;60:93e103.

[158] Coskun D, Aytac J, Aydinli A, Bayer A. Mortality rate, length of stay and extra cost of sternal surgical site infections following coronary artery bypass grafting in a private medical centre in Turkey. J Hosp Infect 2005;60:176e179.

[159] Penel N, Lefebvre JL, Cazin JL, Clisant S, Neu JC, Dervaux B, et al. Additional direct medical costs associated with mosocomial infections after head and neck cancer surgery: a hosptial-perspective analysis. Int J oral Maxillofac Surg 2008;37:135-9

[160] McGarry SA, Engemann JJ, Schmader K, Sexton DJ, Kaye KS. Surgical-site infection due to Staphylococcus aureus among elderly patients: mortality, duration of hospitalization, and cost. Infect Control Hosp Epidemiol. 2004;25:461–467.

[161] Pears, S M. Patient Risk Factors and Best Practices for Surgical Site Infection Prevention. Managing Infection Control 2007; 56-64.

[162] Alexander JW, Solomkin JS, Edwards MJ. Updated recommendations for control of surgical site infections. *A*nn Surg 2011; 253: 1082–1093.

[163] Gaston RG, Kuremsky MA. Postoperative Infections: Prevention and Management. Crit Care Nurs Clin N Am 2012;24:323-344.

[164] Furnary AP, Zerr KJ, Grunkemeier GL, Starr A. Continuous Intravenous Insulin Infusion Reduces Incidence of Deep Sternal Wound Infection in Diabetic Cardiac Surgery Patients. Ann Thorac Surg 1999;67:352-362.

[165] Ata A, Valerian BT, Lee EC, Bestie SL, Elmendorf SL, Stain SC. The Effect of Diabetes Mellitus on Surgical Site Infection after Colorectal and Noncolorectal General Surgery Operations. Am Surg 2010;76(7):697-702.

[166] Dronge AS, Perkal MF, Kancir S, Concato J, Aslan M, Rosenthal RA. Long-term glycemic control and postoperative infectious complications. Arch Surg 2006; 141(4):375-380.

[167] Hoogwerf BJ. Perioperative management of diabetes mellitus: how should we act on the limited evidence? Cleve Clin J Med 2006; 73 Suppl 1:S95-S99.

[168] Stechmiller J. Understanding the role of nutrition and wound healing; Nutrition in clincial practice 2010; 25: 61-8.

[169] Yoshida, Makiko, et al. "Technology and the Prevention of Surgical Site Infections." Journal of Surgical Education 2007; 64(5): 302-310.

[170] Horie H, Okada M, Kojima M, Nagai H. Favorable effects of preoperative enteral immunonutrition on a surgical site infection in patients with colorectal cancer without malnutrition. *Surg Today*. 2006; 36:1063-1068.

[171] Mehta N, Compher C, Directors Abo. ASPEN Clinical guidelines: Nutrition support of the critically ill child. J Parenter Enteral Nutr 2009;33:260-76.

[172] Andersen H, Lewis S, Thomas S. Early enteral nutrition within 24h of colorectal surgery versus later commencement of feeding for postoperative complications. Cochrane Database Systematic Review 2006;CD004080.

[173] Hussey LC, Leeper B, Hynan LS. Development of the Sternal Wound Infection Prediction Scale. [Review] [44 refs]. Heart & Lung 1998; 27(5):326-336.

[174] Perencevich EN, Sands KE, Cosgrove SE, Guadagnoli E, Meara E, Platt R. Health and economic impact of surgical site infections diagnosed after hospital discharge. Emerg Infect Dis 2003; 9:196–203.

[175] Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. Infect Control Hosp Epidemiol 2002; 23:183-9.

[176] Attree M. Patients' and relatives' experiences and perspectives of 'Good' and 'Not so Good' quality care. Journal of Advanced Nursing 2001; 33: 456–466.

[177] Ayliffe GA. Role of the environment of the operating suite in surgical wound infection. Rev Infect Dis 1991;13(suppl 10):S800--4.

[178] Lynch RJ, Englesbe MJ, Sturm L, Bitar A, Budhiraj K, Kolla S, Polyachen- ko Y, Duck MG, Campbell DA. Measurement of foot traffic in the operating room: implications for infection control. Am J Med Qual 2009;24:45–52.

[179] Parikh SN, Grice SS, Schnell BM, Salisbury SR. Operating room traffic: is there any role of monitoring it? J Pediatr Orthop. 2010;30[6]:617-23.

[180] Pryor F, Messmer PR. The effect of traffic patterns in the OR on surgical site infections. AORN J 1998;68:649.

[181] Thiele R, Huffmyer J and Nemergut E. The Six Sigma approach to the operating room environment and infection. Best Practice and Research Clinical Anaesthesiology 2008; 22 (3): 537-52.

[182] Weaving P, Cox F, Milton S. Infection prevention and control in the operating theatre: reducing the risk of surgical site infections (SSIs). J Perioper Pract 2008; 18: 199–204.

[183] Young RS, O'Regan DJ. Cardiac surgical theatre traffic: time for traffic calming measures? Interact Cardiovasc Thorac Surg. 2010;10:526–529.

[184] Simsek Yavuz S, Bicer Y, Yapici N, Kalaca S, Aydin OO, Camur G, et al. Analysis of risk factors for sternal surgical site infection: emphasizing the appropriate ventilation of the operating theaters. Infect Control Hosp Epidemiol. 2006;27(9):958-63.

[185] Knobben BAS, van Horn JR, van der Mei HC & Busscher HJ. Evaluation of measures to decrease intraoperative bacterial contamination in orthopaedic implant surgery. Journal of Hospital Infection 2006; 62: 174–180.

[186] Brandt C, Hott U, Sohr D, Daschner F, Gastmeir P, Ruden H. Operating Room Ventilation With Laminar Airflow Shows No Protective Effect on the Surgical Site Infection Rate in Orthopedic and Abdominal Surgery. Annals of Surgery 2008;248 (5): 695-700.

[187] Bruce N, Ouellet C, Suh K, Roth V. Does High Humidity in the Operating Room (OR) Impact Surgical Site Infection (SSI) Rates? American Journal of Infection Control 2007;35 (5).

[188] Mangram A, Horan T, Pearson M, Silver L, Jarvis W. The Hospital Infection Control Practices Advisory Committee: Guidelines for prevention of surgical site infection. Infect Control Hosp Epidemiol 1999;20:247-80.

[189] Bryce E. Determining the Optimal Surgical Site Infection Surveillance Period. British Columbia Quality Forum. Vancouver, March 2013 [presentation].

[190] Berenguer CM, Ochsner MG Jr, Lord SA, Senkowski CK. Improving surgical site infections: using National Surgical Quality Improvement Program data to institute Surgical Care Improvement Project protocols in improving surgical outcomes. *J Am Coll Surg* 2010; 210: 737–741, 741–743.

[191] Mingmalairak C. Antimicrobial sutures: new strategy in surgical site infections [Internet]. In: Mendez-Vilas A, editor. Science against microbial pathogens: communicating current research and technological advances. Badajoz, Spain: Formatex Research Center; 2011. p. 323 [cited 2014 Apr 22]. (Microbiology book series - number 3). Available from: http://www.formatex.info/microbiology3/book/313-323.pdf

[192] Wang ZX, Jiang CP, Cao Y, Ding YT. Systematic review and meta-analysis of triclosan- coated sutures for the prevention of surgical-site infection. Br J Surg. 2013 Mar;100(4):465-73.

[193] Nakamura T, Kashimura N, Noji T, Suzuki O, Ambo Y, Nakamura F, et al. Triclosan- coated sutures reduce the incidence of wound infections and the costs after colorectal surgery: a randomized controlled trial. Surgery. 2013 Apr;153(4):576-83.

[194] Awad SS. Adherence to Surgical Care Improvement Project Measures and post-operative surgical site infections. Surg Infect., 2012; 13 (4): 234-237.

[195] Hedrick TL, Heckman JA, Smith RL, Sawyer RG, Friel CM, Foley EF. Efficacy of protocol implementation on incidence of wound infection in colorectal operations. J Am Coll Surg. 2007;205:432–438.

[196] Berenguer CM, Ochsner MG Jr, Lord SA, Senkowski CK. Improving surgical site infections: Using National Surgical Quality Improvement Program data to institute Surgical Care Improvement Project protocols in improving surgical out- comes. J Am Coll Surg 2010;210:737–741.

[197] Eskicioglu C, Gagliardi AR, Fenech DS, et al. Surgical site infection prevention: a survey to identify the gap between evidence and practice in University of Toronto teaching hospitals. Can J Surg. 2012; 55:233–238.

[198] Neily et al. Association Between Implementation of a Medical Team Training Program and Surgical Mortality. JAMA 2010;304(15):1693-1701.

[199] Cheng-Le Zhuang, Xing-Zhao, Xiao-Dong Zhange et al. Enhanced Recovery After Surgery Programs Versus Traditional Care for Colorectal Surgery: A Meta-analysis of Randomized Controlled Trials. Diseases of Colon and Rectum. Volume 56: 5(2013).

[200] Teeuwen, P., Bleichrodt, C., Groenewoud, W. et al. Enhanced Recovery After Surgery (ERAS) Versus Conventional Postoperative Care in Colorectal Surgery. (14: 88-95 (2010).

[201] Da Costa A, Kirkorian G, Cucherat M, Delahave F, Chevalier P, Cerisier A, Isaaz k, Touboul P. Antibiotic Prophylaxis for Permanent Pacemaker Implantation: A Meta-Analysis. Circulation 1998;97(18):1796-801.

[202] Gorges M, Ansermino JM, Whyte SD. A Retrospective Audit to Examine the Effectiveness of Preoperative Warming on Hypothermia in Spine Deformity Surgery Patients. Paediatr Anaesth 2013;23(11:1054-61.

[203] Rajek A, Lenhardt R, Sessler DI, Brunner G, Haisjackl M, Kastner J., Laufer G. Efficacy of two methods for reducing postbypass afterdrop. Anesthesiology. 2000 Feb;92(2):447-56.

[204] Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database of Systematic Reviews. 2007(2):CD004985.

[205] Byrne DJ NA, Cuschieri A. The value of whole body disinfection in the prevention of postoperative wound infection in clean and potentially contaminated surgery. A prospective, randomised, double-blind placebo-controlled clinical trial. Surgical Research Communications.1992;12(1):43-52.

[206] Earnshaw JJ, Berridge DC, Slack RC, Makin GS, Hopkinson BR. Do preoperative chlorhexidine baths reduce the risk of infection after vascular reconstruction? European journal of vascular surgery. Aug 1989;3(4):323-326.

[207] Hayek LJ, Emerson JM, Gardner AM. A placebo-controlled trial of the effect of two preoperative baths or showers with chlorhexidine detergent on postoperative wound infection rates. The Journal of hospital infection. Sep 1987;10(2):165-172.

[208] Randall PE, Ganguli L, Marcuson RW. Wound infection following vasectomy. British journal of urology. Oct 1983;55(5):564-567.

[209] Rotter ML, Larsen SO, Cooke EM, et al. A comparison of the effects of preoperative whole-body bathing with detergent alone and with detergent containing chlorhexidine gluconate on the frequency of wound infections after clean surgery. Journal of Hospital Infection. May 1988;11(4):310-320.

[210] Veiga DF, Damasceno CA, Veiga-Filho J, et al. Randomized controlled trial of the effectiveness of chlorhexidine showers before elective plastic surgical procedures. Infection Control and Hospital Epidemiology: the Official Journal of the Society of Hospital Epidemiologists of America. Jan 2009;30(1):77-79.

[211] Wihlborg O. The effect of washing with chlorhexidine soap on wound infection rate in general surgery. A controlled clinical study. Annales chirurgiae et gynaecologiae. 1987;76(5):263-265.

[212] Veiga DF, Damasceno CA, Veiga Filho J, et al. Influence of povidone-iodine preoperative showers on skin colonization in elective plastic surgery procedures. Plast Reconstr Surg. Jan 2008;121(1):115-118; discussion 119-120.

[213] Ellenhorn JD, Smith DD, Schwarz RE, et al. Paint-only is equivalent to scrub-and-paint in preoperative preparation of abdominal surgery sites. Journal of the American College of Surgeons. Nov 2005;201(5):737-741.

[214] Segal CG, Anderson JJ. Preoperative skin preparation of cardiac patients. AORN Journal: Association of periOperative Registered Nurses Journal. Nov 2002;76(5):821-828.

[215] Hort KR, DeOrio JK. Residual bacterial contamination after surgical preparation of the foot or ankle with or without alcohol. Foot & ankle international / American Orthopaedic Foot and Ankle Society [and] Swiss Foot and Ankle Society. Oct 2002;23(10):946-948.

[216] Gilliam DL, Nelson CL. Comparison of a one-step iodophor skin preparation versus traditional preparation in total joint surgery. Clinical orthopaedics and related research. Jan 1990(250):258-260.

[217] Saltzman MD, Nuber GW, Gryzlo SM, Marecek GS, Koh JL. Efficacy of surgical preparation solutions in shoulder surgery. The Journal of bone and joint surgery. American volume. Aug 2009;91(8):1949-1953.

[218] Roberts A, Wilcox K, Devineni R, Harris R, Osevala M. Skin preparation in CABG surgery: a prospective randomized trial. Complications in Surgery. 1995;14(6):724, 741-724, 747.

[219] Sistla SC, Prabhu G, Sistla S, Sadasivan J. Minimizing wound contamination in a 'clean' surgery: comparison of chlorhexidine-ethanol and povidone-iodine. Chemotherapy. 2010;56(4):261-267.

[220] Darouiche RO, Wall MJ, Jr., Itani KM, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. The New England journal of medicine. Jan 7 2010;362(1):18-26.

[221] Bibbo C, Patel DV, Gehrmann RM, Lin SS. Chlorhexidine provides superior skin decontamination in foot and ankle surgery: a prospective randomized study. Clinical Orthopaedics & Related Research. Sep 2005;438:204-208.

[222] Paocharoen V, Mingmalairak C, Apisarnthanarak A. Comparison of surgical wound infection after preoperative skin preparation with 4% chlorhexidine [correction of chlohexidine] and povidone iodine: a prospective randomized trial. Journal of the Medical Association of Thailand = Chotmaihet thangphaet. Jul 2009;92(7):898-902.

[223] Cheng K, Robertson H, St Mart JP, Leanord A, McLeod I. Quantitative analysis of bacteria in forefoot surgery: a comparison of skin preparation techniques. Foot & ankle international / American Orthopaedic Foot and Ankle Society [and] Swiss Foot and Ankle Society. Oct 2009;30(10):992-997.

[224] Veiga DF, Damasceno CAV, Veiga J, et al. Povidone iodine versus chlorhexidine in skin antisepsis before elective plastic surgery procedures: a randomized controlled trial. Plast Reconstr Surg. Nov 2008;122(5):170e-171e.

[225] Berry AR, Watt B, Goldacre MJ, Thomson JW, McNair TJ. A comparison of the use of povidone-iodine and chlorhexidine in the prophylaxis of postoperative wound infection. The Journal of hospital infection. Mar 1982;3(1):55-63.

[226] Ostrander RV, Botte MJ, Brage ME. Efficacy of surgical preparation solutions in foot and ankle surgery. The Journal of bone and joint surgery. American volume. May 2005;87(5):980-985.

[227] Rodrigo, C. The Effects of Cigarette Smoking on Anesthesia. Anesth Prog. 2000;47:143-150

[228] Anderson DJ1, Podgorny K, Berríos-Torres SI, Bratzler DW, Dellinger EP, Greene L, Nyquist AC, Saiman L, Yokoe DS, Maragakis LL, Kaye KS. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014 Jun;35(6):605-27.

[229] http://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf page 9-1

[230] http://www.businessdictionary.com/definition/innovation-adoption-curve.html#ixzz36dPw1sfN

[231] Soriano A, Bori G, Garcia-Ramiro S, et al. Timing of antibiotic prophylaxis for primary total knee arthroplasty performed during ischemia. *Clin Infect Dis.* 2008; 46:1009–14.

[232] Ljungqvist O. Jonathan E. Rhoads Lecture 2011: Insulin Resistance and Enhanced Recovery After Surgery. *JPEN J Parenter Enteral Nutr* 2012 36: 389 originally published online 10 May 2012. DOI: 10.1177/0148607112445580

[233] http://www.erassociety.org/ (accessed 2014-11-10)

[234] Stechmiller JK. Understanding the Role of Nutrition and Wound Healing. Nutrition in Clinical Practice.2010;25:61-68

[235] McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, Ochoa JB, Napolitano L, Cresci G and the A.S.P.E.N. Board of Directors; and the American College of Critical Care Medicine. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). J Parenter Enteral Nutr 2009; 33: 277-316

[236] Canadian Malnutrition Task Force. http://nutritioncareincanada.ca/malnutrition/what-is-malnutrition/

[237] Braga M, Ljungqvist O,Soeters P, Fearon K, Weimann A, Bozzetti F. ESPEN Guidelines on Parenteral Nutrition: Surgery. Clinical Nutrition 28 (2009) 378–386

[238] Andersen HK, Lewis SJ, Thomas S. Early enteral nutrition within 24h of colorectal surgery versus later commencement of feeding for postoperative complications. *Cochrane Database of Systematic Reviews* 2006, Issue 4. Art. No.: CD004080. DOI: 10.1002/14651858.CD004080.pub2

[239] Allard JP, Keller H, Jeejeebhoy KN, Laporte M, Duerksen DR, Garlic L, Payette H, Bernier P, Vesnaver E, Davidson B, Teterina A, Lou W. Contributors to malnutrition at hospital admission and impact on length of stay: A prospective cohort study from the Canadian Malnutrition Task Force. JPEN 2015 DOI: 10.1177/0148607114567902

[240] Bernier P, Leduc N, Machouf N,1996, Unpublished data

[241] Michelle Johnson. *Joint Commission – Standards Interpretation Group*. Personal communication august 16 2011

[242] Council of Europe Committee of Ministers: **Resolution ResAP (2003)3on food and nutritional care in hospitals** (*Adopted by the Committee of Ministers on 12 November 2003 at the 860th meeting of the Ministers' Deputies)* https://wcd.coe.int/ViewDoc.jsp?id=85747

[243] Mueller C, Compher C, Druyan ME and the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Board of Directors. A.S.P.E.N. Clinical Guidelines: Nutrition Screening, Assessment, and Intervention in Adults. *JPEN J Parenter Enteral Nutr* 2011 35: 16 DOI: 10.1177/0148607110389335

[244] www.nutritioncareincanada/resources/

[245] Laporte M , Keller H, Payette P, Allard JP, Duerksen DR, Bernier P, Jeejeebhoy K, Gramlich L, Davidson B, Vesnaver E, Teterina A. Validity and Reliability of the New Canadian Nutrition Screening Tool in the "real-world" hospital setting. European Journal of Clinical Nutrition advance online publication, 17 December 2014; doi:10.1038/ejcn.2014.270. European Journal of Clinical Nutrition (2014), 1–7

[246] Gustafsson UO, Scott M, Schwenk W, Demartines, Roulin D, Francis N, McNaught CE, MacFie J, Liberman AS , Soop M, et al. Guidelines for Perioperative Care in Elective Colonic Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations**.** World Journal of Surgery 2012, DOI: 10.1007/s00268-012-1772-0

[247] Nelson G, et al, Enhanced recovery pathways in gynecologic oncology, Gynecol Oncol (2014) http://dx.doi.org/10.1016/j.ygyno.2014.10.006

[248] Smith I, Kranke P, Murat I, Smith A, O'Sullivan G, Soreide E, et al. Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. European Journal of Anaesthesiology 2011 Aug;28(8):556e69.

[249] Lassen K, Coolsen M, Slim K, Carli F, de Aguilar-Nascimento JE, Schäfer M, Parks RW, Fearon KCH, Lobo DN, Demartines N, et al. Guidelines for Perioperative Care for Pancreaticoduodenectomy: Enhanced Recovery After Surgery (ERAS®) Society Recommendations. World Journal of Surgery 2012, DOI: 10.1007/s00268-012-1771-1

[250] K. Mortensen, M. Nilsson, K. Slim, M. Schäfer, C. Mariette, M. Braga, F. Carli, N. Demartines, S. M. Griffin, K. Lassen and the Enhanced Recovery After Surgery (ERAS®) Group**.** Consensus guidelines for enhanced recovery after gastrectomy: Enhanced Recovery After Surgery (ERAS®) Society Recommendations. British Journal of Surgery, Volume 101, Issue 10, pages 1209–1229, September 2014, DOI: 10.1002/bjs.9582

[251] Cerantola Y, Valerio M, Persson B, Jichlinski P, Ljungqvist O, Hubner M, Kassouf W, Muller S, Baldini G, Carli F, Naesheimh T, Ytrebo L, Revhaug A, Lassen K, Knutsen T, Aarsether E, Wiklund P, Patel HRH. Guidelines for perioperative care after radical cystectomy for bladder cancer: Enhanced

Recovery After Surgery (ERAS®) Society Recommendations**.** Clinical Nutrition, Volume 32, Issue 6, Pages 879-887, December 2013, DOI: 10.1016/j.clnu.2013.09.014

[252] J. Nygren, J. Thacker, F. Carli, K. C. H. Fearon, S. Norderval, D. N. Lobo, O. Ljungqvist, M. Soop and J. Ramirez. Guidelines for Perioperative Care in Elective Rectal/Pelvic Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations. World Journal of Surgery 2012, DOI: 10.1007/s00268-012-1787-6

[253] Okamoto K, Fukatsu K, Hashiguchi Y, Ueno H, Shinto E, Moriya T, Saitoh D, Yamamoto, J Hase K Lack of Preoperative Enteral Nutrition Reduces Gut-Associated Lymphoid Cell Numbers in Colon Cancer Patients A Possible Mechanism Underlying Increased Postoperative Infectious Complications During Parenteral NutritionAnn Surg 2013;258:1059–1064.

[254] Hegazi, H.A. et al. Preoperative Standard Oral Nutrition Supplements vs Immunonutrition: Results of a Systematic Review and Meta-Analysis, J Am Coll Surg, Vol 219(5), 2014, p. 1078-1087

[255] Evans, D.C et al. Nutrition Optimization Prior to Surgery. Nutrition in Clinical Practice, 29(1), 2014, p. 10-21.

[256] van Zanten, A.R. et al. High Protein Enteral Nutrition Enriched With Immune-Modulating Nutrients vs Standard High-Protein Enteral Nutrition and Nosocomial Infections in the ICU: A Randomized Clinical Trial. JAMA, Vol. 312 (5), 2014, p. 514-524.

[257] Burden S, et al. Pre-operative Nutrition Support in Patients Undergoing Gastrointestinal Surgery. Cochrane Database of Systematic Reviews 2012, Issue 11, p. 1-64.

[258] Ljungquist, O. ERAS - Enhanced Recovery After Surgery: Moving Evidenced-Based Perioperative care to Practice, JPEN 2014 38(5) 2014, p. 559-566

[259] The ERAS Protocol http://www.erassociety.org/index.php/eras-care-system/eras-protocol