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## Major article

## Influence of a 5-year serial infection control and antibiotic stewardship intervention on cardiac surgical site infections

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## Key Words:

Antibiotic prophylaxis  
 Cardiac surgical procedures  
 Infection control  
 Surgical wound infection  
 Aminoglycoside

**Background:** Surgical site infections (SSIs) complicate surgery, resulting in higher morbidity and mortality. Infection control bundles and antibiotic stewardship can be effective at reducing SSIs. The influence of long-term serial interventions is unclear.

**Objective:** The goal of this retrospective quasiexperimental study was to assess the influence of a 5-year serial infection control and antibiotic stewardship intervention on SSIs.

**Methods:** The multidisciplinary program actively implemented pre-, intra-, and postoperative strategies over a 5-year period from 2009–2014 for all patients undergoing coronary artery bypass graft (CABG), valve replacement, or both at a tertiary care public institution. Outcomes are compared with a 2-year preinterventions period (2007–2009) and 1-year postinterventions period (2014–2015).

**Results:** A total of 6,518 procedures were included. After interventions, the overall combined infection rate for CABG, CABG and valve, and valve procedures decreased by 66.3%, from 11.9%–4.0% (odds ratio, 0.34; 95% confidence interval, 0.23–0.49;  $P < .001$ ). A significant decrease of >50% ( $P < .001$ ) relative rate was observed in overall, sternum, leg, CABG, and combined CABG and valve infection rates when comparing pre- and postinterventions groups. The antibiotic stewardship intervention increased overall conformity to the internal surgical prophylaxis protocol by 46.8%, from 39.8%–86.6% (95% confidence interval, 41.0–52.4;  $P < .001$ ).

**Conclusion:** Long-term, serial comprehensive infection control and antibiotic stewardship interventions decrease overall SSIs in patients undergoing CABG and valve replacement procedures.

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Surgical site infections (SSIs) can complicate surgery, resulting in higher morbidity and mortality rates.<sup>1</sup> Depending on risk factors, SSIs occur in 2%–5% of surgeries and 1%–2% of cardiac surgeries.<sup>2,3</sup> Some SSIs can be devastating, such as mediastinitis in cardiac surgery, which significantly increases short- and long-term mortality.<sup>4</sup> Its additive treatment cost is the highest at \$63,000 out of all complications following coronary artery bypass graft (CABG) procedure.<sup>5</sup>

Infection control measures are an effective means of reducing SSIs. Multiple studies have shown that measures bundled together effectively reduce SSI rates. Variability on the degree of measures to decrease SSI rates exists amongst studies. An infection preven-

tion and control (IPC) care bundle without modifying antibiotic prophylaxis reduced SSI rates by half.<sup>6</sup> On the other hand, normothermia and normoglycemia as separate interventions individually halve rates, as well.<sup>7,8</sup> Antibiotic prophylaxis for surgical interventions effectively reduces SSIs when the right choice of antibiotic, its dosing, and its duration of administration are respected.<sup>9</sup>

Many studies on infection control bundles and antibiotic stewardship are available for cardiac surgery, but are short-term studies specific to certain SSIs. We describe here a long-term follow-up of cardiac SSIs following serial interventions in a comprehensive infection control and antibiotic stewardship program.

## OBJECTIVE

The goal of this project was to determine the influence of a serial comprehensive infection control and antibiotic stewardship intervention on the reduction of overall SSI rates in cardiac surgery.

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Conflicts of Interest: None to report.

## METHODS

### Design and setting

This quasiexperimental study to determine the effectiveness of a serial comprehensive infection control and antibiotic stewardship intervention on SSIs was conducted in a tertiary care teaching centre (total of 1,081 beds).

### Participants

All patients aged  $\geq 18$  years undergoing elective or urgent cardiac surgery were included. Operated patients were identified from January 2007–March 2015. Those undergoing CABG, combined CABG and valve, and valve procedures were retained.

### Outcome and intervention

The primary outcome was to determine the influence of the interventions on overall SSI rates. The secondary outcomes were to determine the influence of the interventions on organ space, deep incisional and superficial infections at the primary and secondary incision sites, and conformity to the 2013 internal antibiotic prophylaxis guidelines.

Antibiotic stewardship interventions were aimed at improving use of antibiotics in cardiac surgery. Patients undergoing cardiac surgery were also included to determine the influence of the interventions on conformity to the antibiotic prophylaxis guidelines. Exclusion criteria were multiple surgeries within 48 hours, surgeries involving multiple specialities, surgeries where antibiotic prophylaxis was provided but not indicated, and surgeries where antibiotic prophylaxis was indicated without documented administration.

Infection control standard practices before the interventions included shortened preoperative length of stay, hair removal at the surgical site, treatment of active infections before surgery, preoperative shower, skin antisepsis, operating room ventilation, sterile surgical team clothing, sterile operating room and equipment, reduced operating time and room traffic, handwashing, wound dressing, and antibiotic prophylaxis. In April 2009, the IPC department presented recommendations for the prevention of SSIs to the cardiac surgery team. Changes to standard infection control practice were

introduced in May 2009 and became fully operational in September 2009. Annual feedback to surgeons started in June 2009. The medical director of the IPC department and a nursing consultant met the surgeons individually and presented them their infection rates along with the May 2009 recommendations to prevent SSIs. After September 2009, the department periodically measured compliance to the measures. If compliance was under the minimum targeted threshold, the department intervened with recommendations and feedback to the surgical team. Additional recommendations provided in February 2013 emphasized the importance of the following already existing infection control measures:

1. Intra- and postoperative optimal oxygenation to maintain hemoglobin saturation above 95%;
2. Maintenance of pre-, intra-, and postoperative normothermia;
3. Maintenance of intra- and postoperative glycemia  $< 8$  mmol/L and as close to 6 mmol/L for 48 hours after operation.

Modifications to infection control in May 2009 are summarized in [Table 1](#) and are based on the 2008 Society for Healthcare Epidemiology of America/Infectious Diseases Society of America guidelines for the prevention of SSIs.<sup>10</sup> Chlorhexidine sponges were removed from floors and replaced with washcloths. The same applies for chlorhexidine skin antisepsis solution, replaced with chlorhexidine-alcohol solution.

The implementation of an antibiotic stewardship intervention took place between June 2013 and February 2014 and was approved by the McGill University Health Center Research Ethics Board. Institution-specific guidelines for antibiotic prophylaxis were based on the 2013 American Society of Health-System Pharmacists/Infectious Diseases Society of America recommendations and were developed in collaboration with infectious diseases specialists, medical microbiologists, and clinical pharmacists, and surgical teams were consulted for their specific expertise, such that the guidelines were adapted to local practices and microbiology patterns. These guidelines were part of encompassing internal guidelines for the prevention of SSIs published in July 2013, which included new recommendations in the area of infection control. [Table 2](#) summarizes changes in antibiotic prophylaxis in May 2009 and July 2013. A pilot audit and feedback intervention was performed in October 2013. A feedback session with heads of surgical departments was organized and reminder memos were sent to address lacks in

**Table 1**  
Modifications to standard practice introduced in May 2009

Preintervention measures	Postintervention measures
Preoperative	
Shower with 4% chlorhexidine sponge the night before and morning of surgery	2% chlorhexidine-impregnated washcloths applied the night before and morning of surgery
Hair removal with clippers either the night before or morning of surgery	Hair removal with clippers, if necessary, done on call to or in the operating room and limited to the expected dressing size
Identification and treatment of active infections before surgery	Identification and treatment of active infections before surgery. Treatment of asymptomatic colonized urine was added to preintervention treatment. Urine analysis was introduced in the preoperative clinic and if urine was positive for leukocytes or nitrates, a urine culture would be obtained.
None	Preoperative screening for methicillin-resistant <i>Staphylococcus aureus</i> and nasal mupirocin ointment was introduced for every patient for the prevention of <i>S aureus</i> surgical site infection. Screening identified methicillin-resistant <i>S aureus</i> -positive patients so that they could receive vancomycin prophylaxis
Intraoperative	
Skin antisepsis with 0.5% chlorhexidine solution	2% chlorhexidine with 70% alcohol
Postoperative	
Initial dressing removed 48 hours after operation	Initial dressing should be nonocclusive and changed 24 h after operation. If it is soaked and soiled with blood, it can be changed earlier. The dressing should be removed definitely after 48 h
None	Recommendation to pay attention to surgical technique on the vein donor site, including protection of sterile field, was added. Leg edema following donor site was controlled with elastic stockings and compressive bandages were readjusted daily for very obese patients
None	Rapid discontinuation of drains, chest tubes, Foley catheters, and central lines was recommended along with daily assessment of their requirement

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