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Nasal photodisinfection and chlorhexidine wipes decrease surgical site infections: a historical control study and propensity analysis

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SUMMARY

Background: Pre-operative decolonization therapy (DcTx) using chlorhexidine (CHG) body washes and/or intranasal mupirocin can reduce surgical site infections (SSIs), but compliance is often suboptimal.

Aim: To assess the effectiveness of immediate DcTx using a novel approach of intranasal antimicrobial photodisinfection therapy (PDT) combined with CHG body wipes for the reduction of SSIs.

Methods: Between 1st September 2011 and 31st August 2012, 3068 elective cardiac, orthopaedic, spinal, vascular, thoracic and neurosurgical patients were treated with CHG in the 24 h preceding surgery, and received intranasal PDT in the pre-operative area. SSI surveillance methodology remained unchanged from previous years and patients were followed for one year. Results were compared with those for a four-year historical control group of 12,387 patients as well as those for a concurrent control group of 206 untreated patients.

Findings: A significant reduction in the SSI rate was observed between treated patients and the historical control group [1.6% vs 2.7%, $P = 0.0004$, odds ratio (OR) 1.73, 95% confidence interval (CI) 1.2815–2.3453]. This significant reduction was maintained on intent-to-treat analysis ($P = 0.021$, OR 1.37, 95% CI 1.9476–1.7854). Overall compliance with DcTx was 94%. A 1:4 propensity score analysis of matched treated and untreated patients demonstrated that DcTx reduced the risk of SSIs significantly ($P = 0.00026$, $z = 3.65$).

Conclusion: The combination of CHG wipes and PDT immediately before surgery reduced SSIs, achieved excellent compliance, and was easily integrated into the pre-operative routine.

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Introduction

Surgical site infections (SSIs) are among the most common healthcare-associated infections, with substantial morbidity and mortality.[1] The Institute for Healthcare Improvement estimates the additional length of hospital stay to be 7.5 days, with associated costs of $130–856 million/year.[2] Evidence supports decolonization therapy (DcTx) using peri-operative skin antisepsis and/or nasal decolonization with topical mupirocin ointment in an effort to reduce SSIs.[3–5] Unfortunately, compliance with decolonization is often suboptimal.[6]

The availability of prepackaged CHG body wipes for skin antisepsis has facilitated compliance with skin decolonization.[7] Intranasal photodisinfection therapy (PDT) is a promising complementary antimicrobial strategy that uses light energy to activate a photoactive methylene blue dye applied to the anterior nares.[8] It has been used safely and effectively on oral mucosa for the treatment of periodontal infections.[9] The combination of CHG body wipes and intranasal PDT has the theoretical advantage of broad-spectrum antimicrobial efficacy, rapid action, improved compliance, and low risk for development of antibiotic resistance. This paper describes a one-year quality improvement initiative to evaluate the effect on SSIs of using immediate pre-operative DcTx with intranasal PDT and CHG-impregnated wipes in selected non-general surgical populations, specifically elective cardiac, spinal, orthopaedic, thoracic, vascular and neurosurgical patients.

Methods

Study hospital and SSI surveillance programme

Vancouver General Hospital is a 728-bed adult tertiary care facility providing specialty complex surgical care. Procedures performed include coronary artery bypass grafting (with and without valve replacement), hip and knee replacements, craniotomies, ventriculo-peritoneal shunts, spinal procedures (with or without instrumentation/implants), thoracotomies and vascular grafts.[10] The SSI definitions of the Centers for Disease Control and Prevention National Healthcare Surveillance Network are used.[11] Cases are identified through routine surveillance using laboratory data, review of the surgical case list, voluntary surgeon reporting, daily ward reviews, reports from other facilities, and review of hospital re-admissions with a diagnosis of infection; this methodology has been consistent over the last 10 years and throughout the study period.[10]

Study design

From 1st September 2011 to 31st August 2012, patients undergoing cardiac, orthopaedic, spinal, vascular, neurosurgical or thoracic procedures were offered immediate DcTx using CHG-impregnated wipes (Sage Products Inc., Cary, IL, USA) in the 24 h preceding surgery, and intranasal PDT (Ondine Biomedical Inc., Vancouver, Canada) in the pre-operative patient holding area. Patients were provided information on the decolonization programme in the pre-admission clinic or surgeon's office. Licensed practical nurses (LPNs) collected patient information and administered PDT from 0700 h to 1600 h on weekdays and from 0700 h to 1200 h at weekends. The PDT component of DcTx included applying a photosensitizer dye (0.1% methylene blue solution) to the anterior nares for 30 s and two 2-min cycles of illumination with a non-thermal red light with wavelength of 665 nm (Figure 1). Nasal cultures were performed prior to and after PDT therapy; the methods are described below. The study was approved by the ethics committees of Vancouver General Hospital and the University of British Columbia as a quality improvement project.

Data management

The target population was patients undergoing elective clean surgical procedures, normally followed for development of an SSI as part of the infection prevention and control surveillance programme: cardiac, orthopaedic, spinal, vascular, thoracic and neurosurgical patients. Standardized daily data collected by LPNs included demographic information, American Society of Anesthesiologists (ASA) score, type of surgical procedure, surgeon, DcTx completion, compliance, reasons for non-compliance, adverse events and admission status; data were collected even if DcTx was not completed. Data were entered into an Access (Microsoft Corp., Seattle, WA, USA) database which was then exported to the Statistical Package for the Social Sciences (IBM Corp., Armonk, NY, USA) for analysis. Cases that were not routinely followed for SSI surveillance were excluded from the analysis. Cases identified as SSIs by infection preventionists (functioning independently from the project) were entered into a separate Access database as per normal surveillance practice. SSIs were categorized as superficial or deep, and only one SSI per patient was counted. Patients were followed for one year from the time of surgery.

Statistical analysis

The primary outcome was the effect of DcTx on SSI rates. The selected specialty services perform 7500 procedures/year, and an estimated 3300 patients are followed as part of routine SSI surveillance yearly. It was the intent to treat all of the patients routinely followed for SSI surveillance. The intervention group was defined as: (a) treated patients (i.e. patients receiving both CHG and PDT during the study period) and (b) untreated patients (i.e. patients who, unintentionally, did not receive PDT and/or CHG therapy during the study period). SSI rates of treated patients were compared with a historical control group of 12,387 patients. An intent-to-treat analysis was also performed using total SSIs in the treated and untreated patients compared with the historical controls. The literature supports a 30–40% reduction in SSIs with a 'horizontal' (i.e. directed against all potential pathogens) approach.[12] Comparing against a four-year average historical SSI rate of 2.7%, if the programme was expected to reduce SSIs by 35% (to 0.0175), a sample size of 2054 patients was required for an 80% chance to detect a significant difference with an alpha value of 0.05.

Treated patients were also compared with untreated patients using propensity score matching to attenuate potential confounding variables. A 1:4 rather than a 1:1 match was performed given the large imbalance in the numbers between the two groups. Covariates were selected consistent with risk adjustment strategies recommended by the National Hospital Surveillance Network.[11] All cases followed were categorized as clean elective procedures, and the vast majority received general anaesthesia. The additional factors used in matching included age, sex, procedure type, ASA score, total and median surgical