

Surgical Site Infections

203. The DEO Score: A New Scoring System to Better Risk Stratify Post Coronary Artery Bypass Graft (CABG) Surgical Site Infection (SSI) Risk

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Background: With increased interest in public reporting of nosocomial infections, in particular SSI, it is critical that robust risk stratification measures are in place. The NNIS risk index is widely used for all surgeries although its application to clean procedures such as CABG has been questioned.

Objectives: We conducted a prospective cohort study to examine the relative usefulness of the NNIS index and an alternative scoring system to predict SSI.

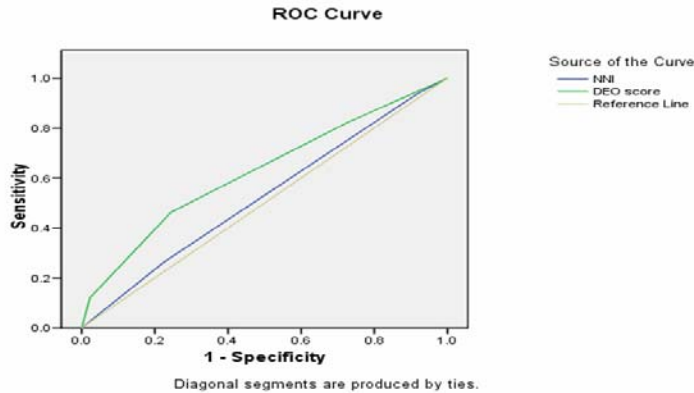
Methods: All patients undergoing CABG from Jan2005 to Sep 2007 at our tertiary teaching hospital were followed for one year post-CABG. SSI were defined using the most stringent NNIS criteria including patients with positive wound microbiologic cultures AND antibiotics prescribed for the infection.

Results: A total of 1379 patients were included in the study, 79% were male, mean age 60.8 ± 9.4 . 731 (53%) had Diabetes (DM).38 (2.8%) patients developed sternal SSI and 137 (9.9%) of them developed leg SSI. A multivariate analysis yielded DM(95% CI 1.30-2.68, $p < 0.001$), emergency surgery(95% CI 1.08-2.18, $p:0.02$), recent myocardial infarct ($p:0.04$), recent stroke ($p:0.04$) and obesity (Body Mass Index > 27.5) (95 % CI 1.48-3.13, $p < 0.01$) to be independent risk factors for all SSI.

A D(iabetes)E(mergency)O(besity) score was calculated with 1 point given each for DM, Obesity and Emergency CABG. A receiver operating curve (ROC) was plotted (Fig 1) to compare the DEO score with the NNIS and the aRoc for DEO was 0.63 as compared to NNIS with aRoc of 0.53. The DEO score also distributed cases more evenly with 26%(359), 46.7%(645), 23.7%(327),3.4%(48) patients with scores of 0,1,2 and 3 compared with 7.9%(110),69.1%(953),22.9%(316) and 0 for NNIS scores 0,1,2 and 3.

Conclusions: The DEO score is easy to use and in our setting might be more helpful in predicting SSI in CABG patients. Further studies are planned to validate this scoring system.

ROC Curve-For All SSI's Comparison between NNIS and DEO



Area Under the Curve					
Test Result Variable(s)	Area	Std. Error(a)	Asymptotic Sig. (b)	Asymptotic 95% Confidence Interval	
				Upper Bound	Lower Bound
NNIS	0.53	0.02	0.26	0.48	0.57
DEO score	0.63	0.02	0.00	0.59	0.67

204. Cefazolin (CEF) or Vancomycin (VAN)? Making a Better Choice for Surgical Prophylaxis of Cardiac (C) Procedures (Ps) or Another Wrong One?

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Background: Surgical site infection (SSI) following CPs ranks high among surgical complications with serious outcomes (mediastinitis, removal of sternal wires, etc) that affect length of stay, hospital cost and mortality. Etiologic agents of SSI after CPs include methicillin-resistant *Staphylococcus aureus* (MRSA). The national Surgical Care Improvement Project (SCIP) now includes VAN as an acceptable prophylactic agent with physician-documented justification in the patient medical record and VAN is justified for CPs in hospitals with a high incidence of MRSA infection. Recent studies have suggested that changing from CEF to VAN may result in an overall decrease in SSI due to gram-positive organisms (GPOs) because many GPOs are now resistant to CEF. In clinical practice, other pathogens such as gram-negative rods (GNRs) are often isolated from SSIs that are not susceptible to VAN and may or may not be susceptible to CEF. VAN use has been associated with an increase in resistant GPOs and outcomes are often less optimal than when a beta-lactam or cephalosporin is used for methicillin-sensitive *Staphylococcus aureus* (MSSA) infections. In our facility, CEF still remains the recommended agent for prophylaxis in CPs.

Objective: To assess if VAN would be an appropriate prophylaxis agent for coronary artery bypass surgery (CABG), valve surgery (V) and heart transplantation (HT) procedures in our facility.

Methods: Retrospective review of SSIs following noted CPs in 2006 and 2007 in hospitalized inpatients. CPs studied CABG, V, and HT. SSIs were analyzed by procedure type. Etiologic agent(s) were identified for each SSI as was susceptibility to CEF and VAN. If no pathogen was found, the isolate was considered resistant (R)

to both agents.

Results: 38 SSIs were identified with 21/38 (55%) following CABG, 11 (29%) in V, 2 (5%) in combined CABG and V, and 4 (11%) in HTs. Pathogens included MRSA, MSSA, and coagulase-negative staphylococcus (CNS), enterococci and GNRs. Five SSIs had mixed pathogens of which one had Candida albicans isolated. See table. Overall, there was no difference in susceptibility to VAN and CEF (50 % vs 32, p=0.16, OR 0.46, CI = 0.16 -1.3), 15/38 (39%) were R to both agents, 4/38 (11%) were sensitive (S) to CEF but not VAN, and 11 (29%) were S to VAN but not CEF.

Conclusions:

1. Beta-lactam S staphylococci only represented 21% of all isolates.
2. GNRs were the most frequently isolated, all R to VAN, however 5/11 (45%) were also R to CEF.
3. VAN plus a broader spectrum GNR agent should be considered for prophylaxis in CPs.

	SSIs	MRS A	MSS A	CNS	VR E	VSE	GNRs	Mixed	No path	CEF S	VAN S	CEF/VAN R
Proc Type	#	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)
CABG	20	3 (15)	5 (25)	4 (20)	1 (5)	0	4 (20)	2 (10)	1 (5)	6/20 (30)	12/20 (60)	7 (35)
CABG + V	3	0	1 (33)	0	0	0	2 (66)	0	0	2/3 (66)	1/3 (33)	1 (33)
V	11	0	1 (9)	2 (18)	0	2 (18)	4 (36)	1 (9)	1 (9)	2/11 (18)	5/11 (45)	5 (45)
HT	4	0	1 (25)	0	0	0	1 (25)	2 (50)	0	2/4 (50)	1/4 (25)	2 (50)
Total	38	3 (8)	8 (21)	6 (16)	1 (3)	2 (5)	11 (29)	5 (13)	2 (5)	12/38 (32)	19/38 (50)	15/38 (39)

205. Risk Factors for Surgical Site Infection after Liver Transplantation

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Introduction: The technical complexity and the associated frequency of surgical site infection (SSI) distinguish liver transplantation (LT) from other common solid organ transplant procedures. Risk factors for SSI after LT, however, have not been

determined using conventional infection control definitions, prospective surveillance and optimal analytic methods.

Objective: To identify risk factors for SSI after LT.

Methods: SSIs after first LT performed at Mayo Clinic, Jacksonville, Florida, in 2003 and 2004 were identified using definitions and methods of the Centers for Disease Control and Prevention's National Nosocomial Infections Surveillance System. Known or suspected risk factors for SSI, including 26 patient, donor or operative characteristics identified on the day of LT and 4 complications occurring within 30 days after LT (abdominal re-operation, rejection, CMV infection and any other infection) were summarized and assessed for association with SSI in single and multivariable analyses using Cox proportional hazards models. Complications occurring after LT were examined as time-varying covariates. In the multivariable analysis, stepwise variable selection was used with a criteria for entry into the model of $P < 0.05$.

Results: Sixty-six (18%) of 370 patients undergoing first LT developed SSI (43 organ/space, 18 superficial, 5 deep). In single variable analysis, increased risk of SSI was associated with Roux-en-Y biliary anastomosis (RR: 1.93, 95% CI: 1.07 - 3.47, $P=0.030$), longer operative time (RR: 1.18 [1 hour increase], 95% CI 1.02-1.36, $P=0.025$) and donor liver mass to recipient body mass ratio less than 0.01 (RR: 2.42, 95% CI:1.10-5.29, $P=0.027$). In multivariable analysis, only operative time (RR: 1.19, 95%CI: 1.03 - 1.37, $P=0.018$) and donor liver mass to recipient body mass ratio less than 0.01 (RR: 2.56, 95% CI: 1.17-5.62, $P=0.019$) had statistically significant associations with the development of SSI after adjusting for other variables. Age, model for end stage liver disease (MELD) score, body mass index, diabetes mellitus, ASA score, wound type and intraoperative red blood cell transfusion requirement were among the collected potential risk factors for SSI that did not have statistically significant associations with SSI in the single or multivariable analyses.

Conclusion: A comprehensive analysis of potential risk factors for SSI following LT found that only increasing operative time and a donor liver to recipient body mass ratio of <0.01 had statistically significant association with SSI after adjusting for other variables.

206. Using Readmission Data to Capture Orthopaedic Post Discharge Surgical Site Infections In Scotland.

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Background: The Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP) team on behalf of Health Protection Scotland (HPS) continue to facilitate national surveillance of surgical site infection (SSI). All of the acute NHS Boards in Scotland participate in the SSI programme. For the period April 2002 - June 2007, 1232 in-patient SSIs, resulting from 82160 operations in ten categories of surgical procedures have been reported to SSHAIP. In the last year 01/7/2006 to 30/06/2007 241 in-patient SSIs resulting from 22830 operations have been reported to SSHAIP.

Objective: As per the mandatory requirements of HDL (2006) 38¹ readmission surveillance until day 30 post operatively for hip arthroplasty procedures has been implemented within all acute NHS Boards in Scotland and in the last year 01/7/2006 to 30/06/2007 23.0% of SSIs in hip arthroplasty have been detected on readmission.

Methods: Data are collected prospectively on eligible patients as per the SSHAIP protocol, from the time of surgery to discharge, death or 30 days post operatively, whichever occurs soonest. A SSI is considered healthcare associated if it occurs within 30 days of surgery. Data are routinely quality assured by SSHAIP. Readmission surveillance must now be undertaken using prospective readmission data for all hip arthroplasty procedures under in patient surveillance up to day 30 post operatively.

Results: The incidence of SSI varies for hip arthroplasty procedure categories dependent on the type of procedure carried out. Operations for primary total hip arthroplasty had the lowest inpatient SSI rate (0.4%), compared with 6.7% for revisions of hip hemi arthroplasty. The influence of surveillance of readmissions also varied within hip arthroplasties, with 47.8% of total primary hip arthroplasties being detected on readmission compared to 0% of revisions of hemi arthroplasty. This analysis indicates that readmission surveillance is worthwhile for hip arthroplasty procedures with an overall increase in the identification of SSIs of 35.2%.

Conclusions: This is the fifth annual report of SSI rates in Scotland. The trends in the SSI rates, over the period the surveillance programme has been in existence, have been relatively stable for hip arthroplasty procedures and appear to have reduced in the last year for knee arthroplasty procedures. Readmission surveillance is mandatory in Scotland for hip arthroplasty procedures. These results indicate that in patient and readmission surveillance accounts for 77.6% of orthopaedic SSI detected.

207. Improvements In Surgical Antibiotic Prophylaxis With Continuous Monitoring Through A Surveillance Program In Victoria, Australia

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The Victorian Healthcare Acquired Infection Surveillance System (VICNISS) is a NHSN based surveillance program which has been in operation since late 2002. The VICNISS coordinating centre collates data from all of the States public hospitals, including data on surgical antibiotic prophylaxis (SAP) from 54 hospitals. Data are collected on choice of antibiotic, timing of the first dose, and duration of prophylaxis. Most measurements of SAP are done as audits or short term projects; however in Victoria we have been collecting data from continuously for almost 5 years and have data on over 50,000 surgical procedures.

Objective: To examine whether regular and continuing reporting to hospitals on compliance with recommendations would result in improvements in administration of surgical antibiotic prophylaxis.

Methods: Data on administration of antibiotic prophylaxis for surgery are submitted routinely as part of a surveillance program for hospital acquired infections. Reports on compliance with surgical antibiotic prophylaxis are fed back to hospitals every 6 months.

Results: Hospitals generally perform well for cardiac and orthopaedic surgery, however compliance is generally less than for other surgery types. Overall improvements have been seen over time for most surgical groups for choice of antibiotic. Timing of the first dose of antibiotic has also shown improvements with compliance for colon surgery increasing from approximately 45% compliance in 2003 to over 70% in 2007.

Conclusions: Regular reporting to hospitals over an extended period has had positive effects on compliance with recommendations for antibiotic prophylaxis. An informal survey has suggested that most hospital infection control staff distribute the reports to departments such as surgery and anaesthesia and some have carried out additional interventions such as educational seminars incorporating the data.

208. Multicenter Evaluation of Enhanced Methods for Inpatient Surveillance of Surgical Site Infections Following Total Knee Arthroplasty

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Background: Inpatient antimicrobial- and diagnosis code-based screening has been shown to be a sensitive method for identifying surgical site infections (SSI) following several different surgical procedures, including coronary artery bypass graft surgery and hip arthroplasty.

Objective: Compare the accuracy of quantitative antimicrobial- and diagnosis code-based screening for identifying SSI after total knee arthroplasty (TKA) to routine prospective surveillance.

Methods: We conducted a retrospective cohort study of 4,194 TKA procedures performed between 7/1/2003 and 6/30/2005 in 5 hospitals located in different geographic areas of the U.S. Routine prospective SSI surveillance was performed at all hospitals. Retrospective medical record review was completed to assess inpatient antimicrobial exposure and the presence of specific discharge diagnosis codes suggestive of SSI during the index surgery hospitalization and subsequent readmissions to the same facility within 365 days following surgery for 1) all TKA procedures associated with SSI by routine prospective surveillance and 2) a random sample of 200 additional TKA procedures at each hospital.

Results: The overall SSI rate based on routine prospective surveillance was 0.9% (median 0.8%, range 0.2%-2.4%). Extrapolating from the number of new SSI identified among the random sample, the adjusted SSI rate was 2.2% (median

2.2%, range 0.8%-3.2%). The best combination of sensitivity and specificity was found by screening for patients with ≥ 7 days of inpatient antimicrobials during the index admission and/or the presence of a discharge diagnosis code suggestive of SSI for the index admission or a readmission within one year of surgery. Patients met these screening criteria after 2% of all TKA procedures. The performance of these methods is shown below.

Hospital	SSI rates based on routine surveillance	Adjusted SSI rates based on enhanced surveillance*	Routine surveillance	Enhanced surveillance*	
				Sens	PVP
			Sensitivity		
Hospital A	0.2%	2.2%	0.11	1.0	0.39
Hospital B	0.6%	2.6%	0.21	0.80	0.73
Hospital C	0.8%	0.8%	1.0	1.0	1.0
Hospital D	1.1%	1.4%	0.67	0.89	0.50
Hospital E	2.4%	2.1%	0.82	0.73	0.44
TOTAL	0.9%	1.9%	0.42	0.86	0.50

* ≥ 7 days of antimicrobials during the index admission and/or a SSI diagnosis code within 365 days of surgery

Conclusions: Routine prospective surveillance failed to detect more than half of SSI following TKA. Focused surveillance among the 2% who met antimicrobial- and/or diagnosis code screening criteria was more sensitive than routine surveillance for detecting SSI. In many hospitals, this method requires less effort than routine surveillance of all patients.

209. Chlorhexidine versus Povidone-Iodine in Skin Antisepsis: A Systematic Review and Cost Analysis to Inform a Medical Center Initiative to Reduce Hospital Acquired Infections

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Background: Hospital-acquired infections (HAIs) like surgical site and line infections are a source of severe medical morbidity costing an estimated 3.5 billion dollars in Pennsylvania alone.

Objective: To inform medical center purchasing decisions relevant to the reduction of HAIs, we compared the efficacy and cost of chlorhexidine versus povidone-iodine in skin antisepsis.

Methods: We performed a systematic review in Medline of prospective controlled trials examining adults receiving topical antiseptics prior to surgery, blood cultures, and vascular or epidural catheter insertion. Study outcomes included positive surface cultures after skin preparation, surgical site infections (SSI), catheter site/tip colonization, catheter-related sepsis and blood culture contamination. Random effects meta-analyses were performed and heterogeneity was assessed using the Q and I² statistic. We also stratified meta-analyses by clinical context. Study quality was measured using a modified Jadad scale. We then used the relevant results of our review to inform a cost-effectiveness analysis comparing the two antiseptic agents in the context of surgical site antiseptics. Efficacy was measured as reduction in SSIs, and costs were average direct hospital costs for those with and without SSIs. The perspective was the hospitals, and the time horizon was the hospital stay. Local administrative data from fiscal year 2006 was used for baseline event rates and costs. One-way sensitivity analyses were performed.

Results: Our search identified 901 studies. Nine met our inclusion criteria. Meta-analysis of all studies demonstrated a significant reduction in infection with the use of chlorhexidine versus povidone-iodine (RR 0.54, 95% confidence interval (CI) 0.36-0.81; Q 27.5, P<0.01; I² = 70.9%). Meta-analysis of studies examining surgical site antiseptics also demonstrated a significant reduction in infection (RR 0.38, CI 0.20-0.72; Q 2.5, P=0.12; I² = 59.5%). Heterogeneity was reduced when analyses were stratified by clinical context. Cost-effectiveness analyses examining the use of chlorhexidine in surgical site antiseptics suggested savings of \$13 per case, or annual hospital savings of \$285,298. Model inputs included a baseline SSI rate of 1.26%, average direct hospital costs for those with and without SSIs of \$14,024 and \$5,422 respectively, and a 25% reduction in SSI with chlorhexidine. Sensitivity analyses demonstrated cost savings with chlorhexidine with SSI reductions of > 12% in all surgeries, and > 2% in cardiac surgeries.

Conclusions: Our analyses suggest that the use of chlorhexidine for skin antiseptics instead of povidone-iodine would result in significant reductions in hospital-acquired infections and hospital costs. These results led our medical center to purchase chlorhexidine for use in surgical site antiseptics.

210. Surgical Site Infection Consequences of Surgeon Trainees and Registered Nurse First Assistants (RNFAs) in Coronary Artery Bypass Graft (CABG) Surgery

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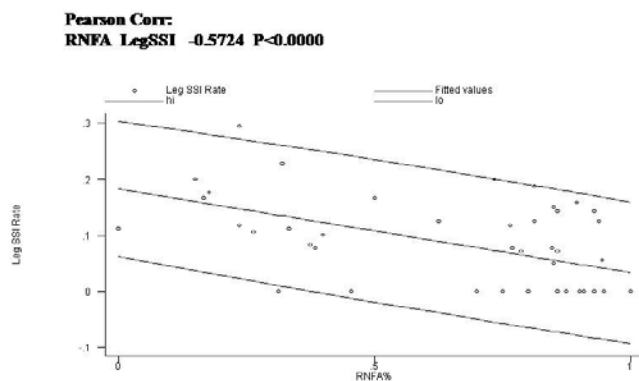
Background: Scrutiny of cardiac surgery training programs has not routinely identified higher patient morbidity or mortality related to surgery performed by surgeon trainees. Conversely, better outcomes have usually been observed in expert programs performing high volumes of surgeries. An increasing percentage of CABG surgeries are being performed on elderly patients who may be more susceptible to complications from inexperienced care. RNFAs are often used to perform routine surgical procedures, such as saphenous vein harvesting and site closure, but there are limited data as to their influence on outcomes, especially in CABG surgeries.

Objective: Investigate the influence of surgeon trainees and RNFAs on sternum and saphenous vein harvest site (SVHS) surgical site infections (SSIs) after CABG surgery.

Methods: A retrospective 1285-patient cohort study, using univariate and multivariate logistic modelling (MLM), evaluated the risk of sternum SSIs when surgeon trainees were primary surgeon of record compared with fully trained staff surgeons as primary surgeon. The risk of SVHS SSI was evaluated comparing surgeon trainees as first assistants to RNFAs in both correlation analyses as well as logistic modelling.

Results: Surgeon trainee status was not a significant predictor of adverse outcome in CABG surgery patients using univariate analysis. However, when modelled as an interaction variable with patients in the cohort's highest age quartile (≥ 73 years old), MLM revealed that surgeon trainee status was associated with a significant, 3-fold increased risk of sternal SSI. Correlation statistics, univariate and MLM consistently identified that when RNFAs were the CABG surgery first assistant of record, the effect was significantly protective against development of SVHS SSI, reducing the risk by 40%-45%.

Correlation of CABG Surgery RN First Assistant with Leg Surgical Site Infections



Conclusions: Interaction variable modelling identified that surgeon trainees as primary surgeons in CABG surgery are associated with increased risk of sternal SSI in elderly patients and may indicate the need for careful patient selection in training programs. RNFAs' expertise in saphenous vein harvesting and prompt leg incision closure significantly reduces the risk of SVHS SSI.

211. Surgical Site Infection Following Tethered Cord Release in a Pediatric Population

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Background: Neurosurgical intervention for tethered cord (TC) syndrome involves breaching the skin barrier in the sacral area, which may be prone to fecal contamination, particularly in patients with compromised bowel and bladder function. Surgical site infection (SSI) following surgery for TC has been reported, but factors associated with post-operative infection have not been documented. A cluster of four cases of SSI detected at our tertiary care pediatric centre over a two month period (April to June 2005) prompted a case-control study to investigate factors associated with SSI following surgery for TC.

Objective: To determine factors associated with SSI following TC release at a tertiary care pediatric centre.

Methods: A retrospective chart review of 4 cases of SSI post TC release and 26 controls over the same time period. Basic demographic data were collected. Descriptive and comparative statistics were used where appropriate.

Results: The median age of the cases was 13 years (range 7 months to 17 years) versus controls (median 7 years, range 3 months to 17 years, $p=0.23$). Their underlying diagnoses included Kabuki syndrome with syringomyelia, scoliosis and congenital heart disease (1 patient), myelomeningocele, Arnold-Chiari malformation type II with ventriculoperitoneal shunt (2 patients) and spinal lipoma with lumbosacral dimple (1 patient). Three of the four had neurogenic bladder and were diapered. In preparation for surgery, all four patients received a bath, Cefazolin prophylaxis and skin preparation with 10% betadine solution. A single surgeon performed all four surgeries ($p=0.049$). The median operating time was 3 hours and 16 minutes (range 1h 50min to 3h 46min) versus controls (median 2h 58min, range 57min to 8h15min; $p=0.81$). For cases there was a median of 11 people (range 9 to 11) in the operating room during the procedure, versus controls (median 11, range 6 to 17; $p=0.41$). The surgical dressing was visibly soiled with stool in the post-operative period in 3 of the 4 cases (75%) compared to 3 of 26 controls (12%; $p=0.018$). Time from surgery to discharge was a median of 7 days (range 5 to 16 days) versus controls (median 5 days, range 3 to 25 days; $p=0.20$). SSI occurred a median of 10 days (range 6 to 12 days) after the surgery, after the patients had been discharged home in 3 of the 4 cases. Organisms isolated from the SSIs included fecal (*E. coli*, other coliforms, enterococcus spp.) and skin flora (coagulase negative staphylococcus).

Conclusions: SSI following TC release was likely related to post-operative fecal contamination of the surgical site, rather than to operative factors. Attention must be paid to the integrity of the dressing post-operatively with the dressing changed immediately if fecal soiling or drainage is evident. This should be emphasized in discharge instructions for site care. Other risk factors may have been significant had the number of cases been larger.

212. Evaluation of Surgical Antibiotic Prophylaxis at a Children's Hospital

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Background: Appropriate antimicrobial prophylaxis has been shown to reduce the incidence of surgical site infections (SSIs).

Objective: The purpose of this study was to evaluate the administration of antibiotic prophylaxis in surgical patients at Children's Hospital in Omaha, Nebraska.

Methods: The data were obtained through a retrospective chart review of medical records for surgeries performed at Children's Hospital in Omaha, Nebraska from January 1 to December 31, 2006. The types of procedures included general surgery (GS), cardiothoracic surgery (CTS), neurosurgery (NS), and orthopedic surgery (OS). The type and dose of antibiotic used, the time of initial administration of the antibiotic with respect to the time of incision, the time of intra-operative administration of antibiotics (if pertinent), and the duration of post-operative administration of antibiotics were recorded. Outcomes recorded included detection of an SSI before the patient was discharged, the patient's length of stay (LOS) in the hospital and in the Intensive Care Unit (ICU), and whether the SSI resulted in mortality. The four most common failures of compliance with prophylactic protocols including administering an inappropriate dose of antibiotic, selecting an inappropriate antibiotic for the specific surgery, inappropriate timing of pre-operative and post-operative administration of the antibiotic, and inappropriate administration of intra-operative antibiotics were noted. The degree of adherence to the CDC guidelines for surgical antibiotic prophylaxis were also recorded.

Results: A total of 1397 surgeries in the 4 selected categories were reviewed. There were 20 SSIs, and 7 mortalities. The LOS was increased due to an SSI in 6 of the 20 cases; the ICU stay was prolonged in 12 of the 20 cases. Of the 20 SSIs, 7 had no pathogen identified, 5 had *Staphylococcus aureus*, 4 had methicillin-resistant *Staphylococcus aureus*, 3 had coagulase-negative *Staphylococcus*, 3 had Gram-negative rods, and 2 had other organisms cultured from the surgical site. The SSIs were seen in the NS, GS and CTS and none resulted in mortality. There was complete compliance with the CDC guidelines only 46.1% of the time. Compliance with at least three of the four criteria occurred 90.7% of the time and compliance with at least two of the four criteria, 100% of the time. Inappropriate timing of antibiotic administration was noted in 39.1% of the procedures. There was no noted association between compliance with CDC guidelines and occurrence of SSIs.

Conclusions: There were few SSIs during the period of study but compliance with CDC guidelines was not consistent. Most notably, the antibiotics were given at an inappropriate time in more than one-third of the cases. Thus, the hospital could benefit from implementing a more strict practice of the correct timing in prophylactic antibiotic administration.

213. Validation Of surgical Site infection (SSI) risk indexes, NNIS and SENIC, In Colombian Private Hospitals And Evaluation of Others Risk potential Factors

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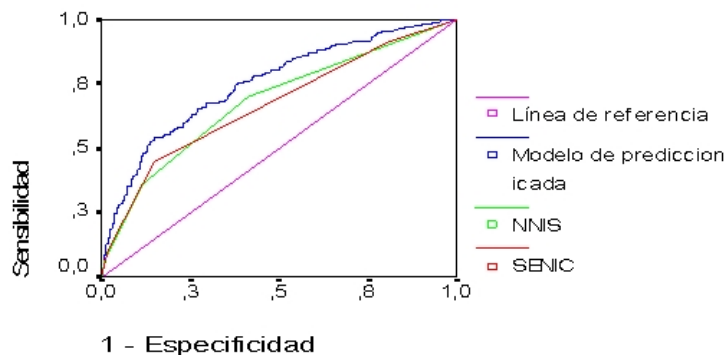
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Objective: Establish the predictive ability for surgical Site infection (SSI) of risk indexes of infection of the National Nosocomial Infections Surveillance System (NNIS) and Study on the Efficacy of Nosocomial Infection Control (SENIC) in Colombian private hospitals and assess the influence of other risk factors.

Methods: A multicenter prospective cohort study was conducted in five institutions of Bogota, Colombia. All patients undergoing surgery requiring hospitalization or ambulatory surgeries with greater risk of infection were enrolled. Case was defined as those subjects who presented the CDC diagnostic criteria of incisional superficial, deep incisional or organ-space SSI. Age, gender, co morbidities, type of surgery, procedures, medical specialty, type of wound, surgical time, antibiotic prophylaxis and patient outcome were used to develop a predictive model of SSI using logistic regression analyses. The predictive ability of indexes was assessed using the area under the receiver operating curve (ROC).

Results: A total of 7022 surgical procedures were evaluated and the rate of SSI was 2.9%. The performance of NNIS and SENIC risk indexes were similar to predict SSI (area under of ROC of 0.68 Vs 0.66, respectively). The new predictive model involved factors as age, diabetes mellitus, transfusions and specialty that showed an operating performance of 0.75

Conclusions: The existing predictive models of SSI have a moderate ability to predict SSI but it can be improved with some local factors.



214. Risk Factors For Deep and Superficial Surgical Site Infection Following Abdominal Hysterectomy

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Background: Surgical site infections (SSI) are associated with significant morbidity and cost of care. SSI incidence estimates after hysterectomy range from 2-9%. There is insufficient understanding of risk factors to build a specific risk stratification index for hysterectomy SSI.

Objective: To identify independent risk factors for deep and superficial SSI after abdominal hysterectomy.

Methods: We conducted a retrospective nested case-control study of 545 abdominal hysterectomies performed for all indications between 7/1/03 and 6/30/05 at 4 institutions. Hysterectomy admissions were identified from hospital procedure logs. SSI patients were identified by routine infection control or enhanced surveillance based on ICD-9-CM diagnosis codes for SSI and/or excess antibiotic utilization followed by medical record review. Potential risk factors collected for cases and controls included age, insurer, tobacco use, diabetes, congestive heart failure, body mass index (BMI), surgery duration, cancer, transfusion, and pre- and postoperative blood glucose and creatinine. Missing values for BMI, glucose, and creatinine were imputed using multiple imputation, and independent risk factors were identified by logistic regression. Statistical analyses were performed using SPSS 14.0 and SAS 9.1.

Results: There were 13 deep, 53 superficial SSI, and 18 organ-space SSI in women after abdominal hysterectomy. The risk factors for organ-space SSI in univariate analysis appeared different from the risk factors for superficial and deep SSI, and thus further analyses focused only on deep and superficial SSI. In women with perioperative glucose measurements, the maximum glucose \leq 5 days after surgery was highest in patients with deep SSI (mean 204 mg/dL), lower in patients with superficial SSI (mean 181 mg/dL) and lowest in control patients (mean 159 mg/dL, $p = .005$). Independent risk factors for deep and superficial SSI included perioperative blood transfusion (adjusted odds ratio (OR) 2.4, 95% confidence interval (CI):1.4-4.4), duration of procedure $>$ 75th percentile (OR 1.7, CI:1.0-3.0), BMI = 25-30 (OR 2.4, CI:0.8-7.2), BMI = 30-35 (OR 3.0, CI:1.0-9.6), BMI $>$ 35 (OR 5.7, CI:2.1-15.6), and Medicaid or no insurance (OR 1.7, CI:0.9-2.9). Serum glucose was not independently associated with increased risk of SSI after controlling for BMI.

Conclusions: Risk of deep and superficial SSI was associated with increased body mass index in a dose-dependent fashion. Other factors associated with increased risk of SSI included blood transfusion and longer operative time. Low socioeconomic status was associated with marginally increased risk of deep and superficial SSI. Integration of these factors into a risk stratification index could help to more accurately predict the risk of SSI following abdominal hysterectomy.

215. Reduction of Orthopaedic Surgical Site Infections during Active Surveillance

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Background: Since 1999, hospitals in the Finnish Hospital Infection Program (SIRO) have reported data on surgical site infections (SSI) following hip and knee arthroplasties. Hospitals prospectively collected data using common definitions and written protocol and also performed postdischarge surveillance.

Objective: To evaluate whether surveillance and feedback of surgical site infection (SSI) information to the physicians and nurses of participating hospitals has led to reduced SSI rates.

Methods: Three categories of operative procedures (total hip, partial hip, and knee arthroplasties) performed during 1999-2005 were included into analyses. Only information from hospitals previously participating for at least three years were accepted (n=26 511). Age, sex, NNIS risk index, hospital volume, historical SSI rate, and proportion of culture-confirmed SSIs adjusted Odds ratios (OR) were calculated for comparison of the SSI rates during 1999-2004 and 2005.

Results: The overall SSI rates for total hip, partial hip, and knee arthroplasty were 3.8% (range by year, 2.4-4.7%), 4.4% (2.1-5.9%), and 2.4% (1.9-3.1%), respectively, and the corresponding rates for deep SSI were 0.6% (0.4-1.1%), 1.5% (0.8-2.8%), and 0.8% (0.6-1.7%). Range of hospital-specific pooled SSI rates during 1999-2004 was 0.8-7.2% and year 2005 0.7-4.5%. A reduction of 33% in the rates of all SSIs following hip and knee arthroplasties was detected (adjusted OR, 0.72; CI95%, 0.56-0.92).

Conclusions: The results suggest that SIRO as a voluntary surveillance system can support other SSI prevention efforts and lead to reduced SSIs.

216. Procedures associated with Total Abdominal Hysterectomy increase the risk of Surgical Site Infection.(SSI).

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Background: The risk for Surgical Site Infection (SSI) is influenced by many factors including the type and complexity of the operation. Comparison of quality between surgeons and hospitals will soon be made based on processes and outcomes including SSI rates. SSI rates after total abdominal hysterectomy (TAH) is one of the measures that is being considered for public reporting. We reviewed the SSIs after TAH cases at Mayo Clinic Rochester (MCR) for 3 years to determine whether concurrent procedures contributed to the risk for SSI.

Methods: Retrospective analysis of data collected by infection control practitioners as part of routine surveillance during January 2004- 2006. SSI rates were calculated for all TAH cases, cases where the only additional procedure was bilateral salpingo-

oophorectomy (BSO), and for TAH, BSO where other procedures were performed concomitantly. Infected cases (SSI) were obtained from the Infection Prevention and Control database and matched to the combinations of procedure codes in the denominator.

Results: During the 3 year period, there were 1746 operations where TAH was listed as the primary procedure. 90 SSIs were diagnosed among these cases for an overall SSI rate of 5.1% which is higher than the 1.9% rate (range 1.36% - 5.17% based on risk group) rate reported by National Nosocomial Infection Surveillance system (NNIS).

When the procedure was TAH with BSO only the SSI rate was 2.8%, the SSI rate was similar when omentectomy and node resections were performed. (Table 1) SSI rate after TAH, BSO with bowel resection was higher at 3.9 % but this difference was not statistically significant. Tumor debulking was associated with six fold increased risk of SSI (95% confidence interval 3.3-10.2, $p < .001$). Panniculectomy and lysis of adhesions also increased the risk of infection significantly but the number of cases was small.

Conclusions: SSI risk after TAH, BSO is not increased by concomitant omentectomy or node resections but is significantly increased by tumor debulking. Bowel resection did not increase the SSI risk in our analysis, but this may due to the small number of patients who had this procedure and this risk factor warrants further study. When reporting SSI rates for quality purposes, rates for operations that involve tumor debulking should be reported separately.

Table 1. Risk of SSI after TAH

Procedure	Number	Number of SSI	SSI rate	Relative Risk (95% CI)	P value
TAH+BSO	945	26	2.8%	Reference Rate	N/A
TAH +BSO+ omentectomy	224	6	2.7%	1.0 (0.4-2.3)	0.9
TAH+BSO+ node resection	274	8	2.9%	1.1 (0.5-2.3)	0.9
TAH+BSO+bowel resection	152	6	3.9%	1.4 (0.6-3.3)	0.4
TAH+BSO+tumor debulking	112	18	16%	5.8 (3.3-10.2)	<0.001

217. *Staphylococcus aureus* Nasal Colonization in Preoperative Orthopaedic Surgery Outpatients

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Background: Nasal colonization of *Staphylococcus aureus* results in increased risk of surgical site infection (SSI).

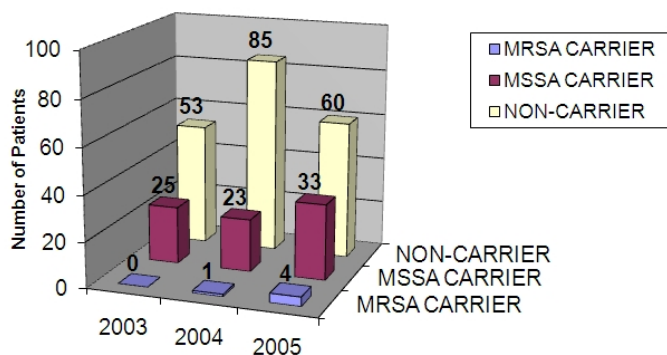
Objective: The goal of this study was to determine the prevalence of *S. aureus* (both methicillin sensitive and resistant) nasal colonization among pre-operative orthopedic surgery outpatients.

Methods: Between 9/19/2003-9/26/2005, nares were cultured on preoperative outpatients within 2 weeks of orthopedic surgery. Patients positive for *S. aureus* were offered decolonization.

Results: Of 284 patients, 30.3% carried *S. aureus*. 94.2% were colonized with methicillin-sensitive *S. aureus* (MSSA) and 5.8% with methicillin-resistant *S. aureus* (MRSA). 3.2% developed SSI, 4 of which were due to *S. aureus*. There were no associations between nasal carriage and demographics or procedures. Total *S. aureus* colonization increased from 32.4% to 38.1% and colonization specifically with MRSA increased from 0.0% to 4.1% over the study period. None of the 43 carriers who received decolonization therapy developed SSI due to *S. aureus*, but 2 of the other 43 colonized patients who declined decolonization developed an SSI, and both were due to *S. aureus*. Among the non-carriers, 1.0% developed a SSI due to *S. aureus*.

Conclusion: A substantial proportion (30.3%) of pre-operative orthopedic surgery patients carry *S. aureus*. The increase in carriage rates of *S. aureus* over time might be attributed to increasing MRSA in the community. Knowledge of colonization status may be important in choosing perioperative antibiotics, empiric treatment, and decolonization.

Colonization Status of the 284 Patients Screened



218. Outbreak of Surgical Site Infections Following Coronary Artery Bypass Graft Surgery – United States, 2007

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Background: Surgical site infections (SSIs) occur in approximately 300,000 patients annually in the U.S., representing the second most commonly reported nosocomial infection. SSIs are rarely due to *Pseudomonas aeruginosa*. In 2007, Hospital A experienced a 5-fold increase in SSI rates following coronary artery bypass graft (CABG) surgery. *P. aeruginosa* was isolated from the wound in nearly half of the cases.

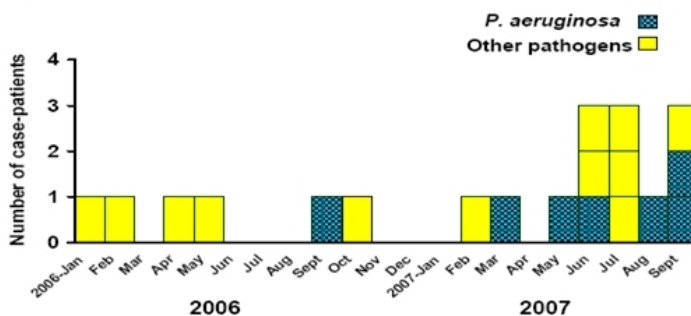
Objective: An investigation was initiated to review infection control practices, identify the cause of infection, and recommend prevention measures.

Methods: A case-control study was performed. Case-patients underwent CABG surgery between January and September, 2007 and developed a sternal SSI within 45 days. Controls underwent CABG surgery during the same period and did not develop a sternal SSI. Staff were interviewed and infection control practices were observed. Environmental samples were obtained and *P. aeruginosa* isolates from case-patients were typed using pulsed-field gel electrophoresis (PFGE).

Results: There were 13 case-patients; seven had deep sternal wound infections and six had superficial sternal wound infections. SSIs were associated with higher perioperative glucose ($p=0.03$), admission from another facility ($p=0.02$), and surgeon B ($p=0.006$). Multivariable analysis adjusted for perioperative glucose, admission from another facility, and procedure duration revealed that case-patients had higher odds of having surgery performed by Surgeon B (aOR=4.7, 95% CI=1.02-21.9). This association was supported by staff interviews describing surgeon-specific breaches in infection control and a temporal relationship between the increase in infections and Surgeon B joining the hospital staff. No environmental sources of *P. aeruginosa* were identified. PFGE analysis indicated the three *P. aeruginosa* patient isolates available for testing were unrelated.

Conclusion: Epidemiologic analysis and interviews suggest that the outbreak was associated with infection control lapses, especially in association with Surgeon B. This outbreak highlights the need for vigilance regarding adherence to recommended infection prevention practices and the importance of calculating and sharing surgeon-specific SSI rates with surgeons.

Epidemic Curve for Surgical Site Infections Following Coronary Artery Bypass Graft Surgery at Hospital A



219. The Attributable Costs of Surgical Site Infection and Endomyometritis Following Low Transverse Cesarean Section

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Background: Surgical site infection (SSI) and endomyometritis (EMM) following cesarean section are a significant source of morbidity. Data on attributable costs for these infections are limited despite the very large number of procedures performed and the relatively common occurrence of SSI and EMM.

Objective: To determine the attributable costs associated with SSI and EMM following low transverse cesarean section (LTCS) using administrative data.
Methods: Prospective cohort of women undergoing LTCS at Barnes-Jewish Hospital, a 1250-bed academic medical center from 07/1999 to 06/2001. Comorbidity and procedure variables were created from ICD-9-CM codes collected from the hospital Medical Informatics database. Cost data were obtained from the hospital Trendstar financial database and inflation adjusted to 2006 dollars using the medical care component of the CPI. Potential SSI and EMM cases were identified by ICD-9 diagnosis codes and/or antibiotic utilization in the surgical admission or readmission to the hospital or emergency room within 30 days of surgery. SSI and EMM cases were verified by chart review using the CDC National Nosocomial Infections Surveillance System definitions. Total costs incurred from the date of LTCS through 30 days after surgery by subjects with SSI and/or EMM were compared to total costs incurred by control uninfected subjects. Ln-transformed costs were used as the dependent variable in a multivariate generalized least squares model to determine attributable costs.

Results: 1597 LTCS were performed during the study period. 80 (5.0%) SSI cases and 121 (7.6%) EMM cases were identified. Patients with SSI and/or EMM had a longer median hospital LOS during their surgical admission than uninfected control patients (EMM cases 6.6, SSI cases 5.8 days vs. 4.5 days for uninfected patients; $P < .001$ for both). SSI and EMM case patients had significantly higher crude unadjusted costs (SSI median \$9,529; range \$4,344-\$129,757, EMM median \$10,291; range \$3,923-\$52,893, compared to uninfected controls median \$6,308; range \$1,517-\$256,388; $P < .001$). Both SSI and EMM were independent predictors of increased costs in the multivariate model after controlling for 24 other significant predictors of cost (adjusted $R^2 = 0.25$, $P < .001$), including age <18 years, pre-eclampsia or eclampsia, chorioamnionitis, venous catheterization, severe complications of delivery, pneumonia, ovary operations, and obstetric laceration or trauma. The attributable cost of SSI was \$3,043 (95% CI \$2,698-\$3,432) and the attributable cost of EMM was \$3,186 (95% CI \$2,825-\$3,594).

Conclusion: Both SSI and EMM were associated with significantly increased hospital costs in this population. The use of readily available administrative data with a standardized coding scheme may be beneficial for simplified data collection and comparison of cost estimates of nosocomial infections across institutions.

220. Gram Negative Surgical Site Infections in Community Healthcare Settings

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Introduction: The epidemiology of gram-negative (GN) surgical site infections (SSI) in the community healthcare setting, has not received as much attention as gram-positive infections. The objective of this study was to examine the epidemiology of GN-SSIs in the community setting.

Methods: This cohort study included prospectively collected data on surgical procedures and subsequent SSIs in patients from 29 hospitals in the Duke Infection Control Outreach Network (DICON) from 1/1999-12/2006. Identical surveillance methods were used at all study hospitals. SSIs were prospectively identified using standard CDC definitions. Variables analyzed included type of surgery, SSI pathogen and rate of SSI. Rates of SSI were expressed per 100 procedures.

Results: A total of 3988 SSIs occurred following 354,111 surgeries (1.12 SSI per 100 procedures) in 29 hospitals. 821 (20%) of these 3988 infections were due to gram-negative organisms (rate of GN-SSI = 0.23 per 100 procedures). The following 6 procedures accounted for the majority of GN-SSIs: colorectal surgeries (17%), vascular surgeries (8%), exploratory laparotomies (7%), fracture reduction (5%) cesarean sections (5%), and coronary artery bypass surgeries (4%). The five most common gram-negative pathogens were *E. coli* (25%), *Pseudomonas* spp. (17%), *Enterobacter* spp. (12%), *Klebsiella* spp. (10%) and *Proteus* spp. (9%). For our cohort of patients, the 10 procedures with the highest risk of GN-SSIs are shown in Table 1.

Conclusion: Gram-negative pathogens caused one in 5 SSIs in patients in our network of community hospitals. Biliary, bowel and surprisingly neuroaxial and vascular surgeries all had high rates of GN-SSI. Whilst much emphasis has been placed on preventing gram-positive SSIs particularly those due to MRSA, GN-SSIs remain an important problem in community hospitals. Further study is required to determine if specific antimicrobial prophylaxis regimens lead to higher rates of GN-SSIs. For example, patients undergoing vascular or spinal procedures may have higher rates of gram-negative SSI if certain regimens without gram-negative coverage (such as vancomycin) are used as single agents in patients with allergy to beta-lactam antibiotics.

NNIS Code	Infections	Surgeries	Rate of SSI per 100 procedures	GN-SSI, rate per 100 procedures	non-GN-SSI, rate per 100 procedures
Total	3988	354,111	1.12	0.23	0.89
Small Bowel (SB)	46	856	5.37	1.52	3.86
Colon (COLO)	454	9680	4.69	1.43	3.26

Peripheral Arterial Bypass Surgery (PVBV)	39	747	5.22	1.34	3.88
Vascular (VS)	258	12516	2.06	0.53	1.53
Nephrectomy (NEPH)	18	1201	1.50	0.50	1.00
All Open Appendix (APPY & OAPPY)	77	5360	1.43	0.44	0.99
Cholecystectomy (CHOL)	32	1979	1.62	0.40	1.21
Other Digestive (OGIT)	9	1010	0.89	0.40	0.50
Craniotomy (CRAN)	32	2282	1.40	0.39	1.01
Instrumented Spinal Fusion (IFUSN)	92	5096	1.81	0.37	1.43