RESEARCH BRIEFS

Surgical Site Infections and Compliance with Perioperative Antimicrobial Prophylaxis in Greek Children

Surgical site infections (SSIs) are the second most common healthcare-associated infection in adults and children, representing up to 16% of all infections reported to the National Healthcare Surveillance Safety Network of the Centers for Disease Control and Prevention (CDC). SSIs increase patient morbidity and mortality as well as healthcare costs.[1,2] Few data exist about pediatric SSI rates and perioperative antimicrobial prophylaxis (AP) practices in children, especially from Europe.[3-5] Acquiring these data is particularly important in Greece, because healthcare-associated infection rates, antimicrobial consumption, and prevalence of multidrug-resistant organisms are among the highest observed in developed nations. We sought to determine the incidence of SSIs and to evaluate current perioperative AP practices among pediatric surgery patients in Greece.

We performed a 7-month prospective surveillance study of surgical procedures (January through July 2013) at Aghia Sophia Children's Hospital (Athens, Greece). All inpatients and outpatients subjected to 1 or more surgical procedures, as defined by the CDC, were eligible to be included. If multiple procedures took place during a single trip to the operating room, this was defined as a single surgery. Patients subjected to procedures in which edges of skin incision were not fully closed were excluded.[1]

We modified the CDC's Denominator for Procedure form[6] and collected demographic data, perioperative AP data (antimicrobial agents, administration route, and duration of AP), procedure data (type and duration of procedure, use of implants, wound classification, and elective versus urgent procedure) and postprocedure data (therapeutic use of antimicrobials, postoperative hospital stay, and presence of an SSI).

All postoperative patients were observed daily by the surgeons until hospital discharge. After discharge, telephone follow-up was performed by 2 of the study authors at 30 days (no implant) or at 6 months (implant placed) after surgery to assess whether an SSI had occurred. SSIs were diagnosed and classified as superficial incisional, deep incisional, or organ/space using standard CDC definitions.[6] A standardized paper data collection form was used, and data were then entered into an electronic database (RedCap).

Overall SSI rates per 100 operative procedures were calculated according to the CDC's instructions.[6] SSI rates were also calculated by wound class and procedure type. The procedures were grouped as procedures of the scrotum/inguinal region, urinary tract, skin/soft tissue, liver/biliary, intestinal tract and anus, appendectomies (complicated and uncomplicated), oncologic procedures, umbilical and abdominal wall hernia repair, and other procedures, such as pyloromyotomy, varicocele repair, and pediatric gynecology procedures.

Appropriateness of perioperative AP was assessed as the administration of preoperative doses of the correct antimicrobial agents for specific surgical procedures, and the correct duration of AP for less than 24 hours, according to American Society of Health-System Pharmacists recommendations.[7] Patients who underwent procedures with an established infection were excluded from analysis of AP.

All categorical variables were summarized as absolute number and relative frequency (%). Duration of AP was summarized as median and interquartile range because Shapiro Wilk test revealed that this was not normally distributed. SSI rates were presented as percentage and 95% confidence interval.

During the study period, a total of 553 children underwent surgery. The most frequent surgeries were procedures of scrotum and inguinal region (38.5%), appendectomies (28.9%), and procedures of urinary tract (13.9%). The SSI rates by wound type and procedure type are shown in Table 1.

Perioperative AP was administered to 425 of 513 eligible patients (40 were receiving antimicrobial treatment for infection at the time of surgery). Of the 425 patients who received AP, 410 (96.5%) had an indication, whereas 15 patients (3.5%) did not have an indication for AP. Of these 410 patients with an indication for AP, 118 (28.8%) received the correct antimicrobial agent. The most common AP was cefoxitin (44.2%), followed by gentamicin (26.8%) and metronidazole (21.4%). The median duration of AP was 7 days (interquartile range, 3–9 days), and only 85 patients (20.7%) received the appropriate duration of AP (for 24 hours).

Only 23 (5.6%) of the patients received the appropriate AP in terms of both the correct antimicrobial agent and duration. Eighty-six (97.7%) of the 88 patients who did not receive AP met indication criteria for AP.

To our knowledge, this study is the first to estimate the SSI rate among Greek children and to measure adherence to current AP guidelines in Europe. This study revealed an overall SSI rate of 2.2%. These data can provide valuable benchmarking data for other European pediatric facilities.

As expected, we found that SSI rates were higher after contaminated and dirty-infected procedures compared with clean and clean-contaminated procedures.[4,5] We found significant gaps in adherence to current AP guidelines. In our study, the rate of overall AP compliance was low. The most common reasons for inappropriate perioperative AP were either selection of drug(s) that did not cover potential pathogens or redundant coverage, whereas prolonged postoperative courses of antibiotics were common. Also, 16.8% did not receive antimicrobials even though AP was indicated.

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TABLE 1. Surgical Site Infection (SSI) Rates by Wound Class and Procedure Type

Variable	No. (%) of cases	No. of SSIs	SSI rate (95% CI)
By wound class			
Clean	112 (20.3)	0	0.0 (0 – 3.2)
Clean-contaminated	382 (69.1)	4	1.0 (0.3 – 2.7)
Contaminated	21 (3.8)	2	9.5 (1.2 – 30.4)
Dirty	38 (6.9)	6	15.8 (6.0 – 31.3)
By procedure type			
Appendectomy complicated	31 (5.6)	6	19.4 (7.4 – 37.5)
Appendectomy noncomplicated	129 (23.3)	2	1.6 (0.2 – 5.5)
Small intestine	10 (1.8)	1	10 (0.2 – 44.5)
Oncologic	14 (2.5)	1	7.1 (0.2 – 33.9)
Urologic	77 (13.9)	1	1.3 (0.03 – 7.0)
Pyloromyotomy	4 (0.7)	0	0.0 (0.0 – 60.2)
Umbilical hernia/abdominal wall hernia	12 (2.2)	0	0.0 (0.0 – 26.5)
Varicocele	4 (0.7)	0	0.0 (0.0 – 60.2)
Inguinal/scrotum	213 (38.5)	0	0.0 (0.0 – 1.7)
Large intestine/anus	17 (3.1)	0	0.0 (0.0 – 19.5)
Pediatric gynecology	4 (0.9)	0	0.0 (0.0 – 52.2)
Liver/biliary tract	7 (1.3)	0	0.0 (0.0 – 40.9)
Skin/soft tissue	23 (4.2)	1	4.3 (0.1 – 21.9)
Intussusception	4 (0.7)	0	0.0 (0.0 – 60.2)
Other	3 (0.5)	0	0.0 (0.0–70.8)
Overall	553	12	2.2 (1.1–3.8)

NOTE. CI, confidence interval.

Although we were not able to assess the timing of administration of AP or the need for redosing, we identified important targets for intervention. Additionally, we did not capture surgeon-specific data, which limited our ability to provide personalized feedback. Finally, we were not able to perform audits of adherence to other infection control practices, which might have increased the risk of SSI. Our future directions include interventions to educate surgeons to improve the selection of appropriate drugs and limited durations of AP.

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REFERENCES

1. Yi M, Edwards JR, Horan TC, Berrios-Torres SI, Fridkin SK. Improving risk-adjusted measures of surgical site infection for the National Healthcare Safety Network. *Infect Control Hosp Epidemiol* 2011;32:979–986.
2. Gaynes R, Richards C, Edwards JR, et al. Feeding back surveillance data to prevent hospital-acquired infections. *Emerg Infect Dis* 2001;7:295–298.
3. Brown SM, Eremin SR, Shlyapnikov SA, et al. Prospective surveillance for surgical site infection in St. Petersburg, Russian Federation. *Infect Control Hosp Epidemiol* 2007;28:319–325.
4. Uludag O, Rieu P, Niessen M, Voss A. Incidence of surgical site infection in pediatric patients: a 3-month prospective study in an academic pediatric surgical unit. *Pediatr Surg Int* 2000;16:417–420.
5. Varik K, Kirsimagi U, Varimae A, Eller M, Loivukene R, Kubarsepp V. Incidence and risk factors of surgical wound infection in children: a prospective study. *Scand J Surg* 2010;99:162–166.
6. Centers for Disease Control and Prevention. National Healthcare Safety Network: surgical site infection (SSI) event. http://www.cdc.gov/nhsn/PDFs/pscManual/9pscSSIcurrent.pdf. Accessed June 26, 2010.

7. Bratzler DW, Dellinger EP, Olsen KM, et al. ASHP report: clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm* 2013;70:195–283.

Prolonged Hospital Stay, an Adverse Effect of Strict National Policy for Controlling the Spread of Highly Resistant Microorganisms

Healthcare facilities (HCFs) are increasingly plagued by highly drug-resistant organisms (HDROs).[1] These HDROs include carbapenamase-producing Enterobacteriaceae (CPE) and glycopeptide-resistant enterococci (GRE), with low prevalence rates in France.[2,3] French recommendations for the control of HDROs consist of strict contact precautions for colonized patients, screening and contact precautions of contact patients, with neither transfer nor new admissions until 3 negative screening tests.[4] However, this strategy is burdensome and limits use of hospital services. Difficulties in implementing these measures may induce reluctance of downstream HCFs to accept admission of HDRO-positive patients. Our purpose was to describe the length of stay (LOS) and evaluate the delay in transferring patients colonized with HDROs to downstream units.

This study was performed at a 950-bed university hospital. We conducted a matched case-control study from January 2009 to January 2013. Cases were defined as patients colonized or infected with HDRO. Control patients were those not colonized or infected with HDROs. Control patients were those matched with cases on gender, age, first ward and period of hospitalization (same period during the previous or following year), and diagnosis-related groups (DRGs). All possible controls were selected from the DRG system and included. Data were retrospectively collected: comorbidities, type of HDRO, date of positive result, dates of admission and discharge, destination at discharge, origin of the HDRO (either referred to the hospital or acquired in our hospital) and DRG.[5] A hospital-acquired HRDO was defined as an HDRO cultured from screening or clinical samples more than 48 h after admission, and infection was defined according to standard criteria.[6] LOS was calculated by the difference between discharge and admission dates at our hospital. Univariate comparisons used a Wilcoxon rank or χ^2 test. LOS had a right-skewed distribution and was log transformed. Mean LOS of cases and controls was compared using general linear model analysis for matched data in SAS, LSMEANS (SAS Institute).

In total, 190 patients were included, 49 cases and 141 controls (Table 1). Twenty-eight cases were colonized with GRE (25 *van*A, 3 *van*B enzymes), 19 with CPE (16 OXA-48, 2 KPC, 1 NDM-1 enzymes) and 2 with both HDROs. Twenty-four cases (49%) were hospital acquired, 18 with GRE and 6 with CPE; 19 (39%) cases were secondary to an outbreak occurring in our hospital, 15 with GRE and 4 with CPE. Median duration between admission and date of HDRO-positive culture was 11 days (interquartile range [IQR], 6–20). Four cases developed an infection with HDROs. The number of cases increased over time, from 1 in 2008 to 25 in 2012. The median Charlson score was significantly higher in cases than in controls, and the McCabe score was similar (Table 1). Median LOS was 31 (15–72) days in cases and 14 (8–25) days in controls ($P < .01$). Patients were hospitalized primarily in medical units before discharge in cases ($n = 25$, 51%) and controls ($n = 77$, 55%, $P = .79$); 32 cases (68%) and 91 controls (64%) were discharged home ($P = .96$). After adjustment for ward, MDRO colonization status, type of care required for primary diagnosis, and destination at discharge, there was a statistically significant difference in duration of hospitalization between the HDRO group and the HDRO-free group. Log-transformed matched adjusted mean LOS was estimated at 45.1 days in cases and 21.4 days in controls ($P < .001$). Mean excess LOS due to colonization with HDRO was 23.7 days (95% confidence interval [CI], 21.3–26.1).

French national recommendations are effective in controlling the spread of HDROs.[7,8] However, this strict policy may have adverse effects on the care of colonized patients[9] and may cause a delay in transfer to downstream HCFs. Our results suggested that colonization with HDROs was associated with a mean excess LOS of 23.7 days. The national strategy for controlling HDROs is based on strict contact precautions for colonized and contact patients, with implementation of cohorting and dedicated staff in an outbreak situation. This strategy leads to potential adverse clinical and economic effects. Indeed, costs generated by HDRO control include loss of income due to interruption of transfers and admissions and costs of additional staff for cohorting, microbiological tests, and contact precautions.[10] These costs may prevent HCFs from admitting these patients, especially to rehabilitation units or long-term care facilities (LTCFs), where resources may be scarce. In addition, care of HDRO carriers may disrupt care organization, eg, rehabilitation in dedicated areas. Additionally, the perceived risk of transmission may be enhanced by healthcare workers' perceived risk of HDRO acquisition and fear of these "high-risk bugs." The major strength of our study is the statistical method, which addresses group differences in matched patients, therefore minimizing confusion bias due to demographic characteristics, comorbidity, and the hospitalization context and providing an accurate estimation of excess LOS due to HDRO. However, the single-center design limits generalizations, since connections between acute care and rehabilitation or LTCFs are specific to each healthcare network. This also argues for flexible recommendation in units with limited human and budget resources. Additionally, controls were matched to cases for hospital stay during the year before or after the episode, thus controlling for the potential impact of preventive measures