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Short Communication

Predictive factors of post-discharge surgical site infections among patients from a teaching hospital

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ABSTRACT

Introduction: Surgical site infections (SSIs) often manifest after patients are discharged and are missed by hospital-based surveillance. **Methods:** We conducted a case-reference study nested in a prospective cohort of patients from six surgical specialties in a teaching hospital**.** The factors related to SSI were compared for cases identified during the hospital stay and after discharge. **Results:** Among 3,427 patients, 222 (6.4%) acquired an SSI. In 138 of these patients, the onset of the SSI occurred after discharge. Neurological surgery and the use of steroids were independently associated with a greater likelihood of SSI diagnosis during the hospital stay. **Conclusions**: Our results support the idea of a specialty-based strategy for post-discharge SSI surveillance.

Keywords: Infection control. Surgical site infections. Surveillance.

A huge number of patients are submitted to surgical procedures in Brazilian hospitals every year. Surgical site infections (SSIs) pose a special threat to those patients, leading to the increased use of antimicrobials, prolonged hospitalizations, permanent sequelae or even death. SSIs have also been associated with the acquisition of multidrug-resistant organisms[1]. Although there are no data on the overall SSI incidence in Brazil, the Program for Surveillance of Healthcare Associated Infections in the State of São Paulo (PSHAISP) reported median rates of approximately 0.6% for clean wound procedures from 546 hospitals[2]. Clean/contaminated, contaminated and dirty wound surgeries – which are not a focus of that program – are expected to present a higher incidence of SSIs[3]. In addition, the official rates may be underestimates due to inaccurate reporting and the lack of a requirement by the PSHAISP for hospitals to perform post-discharge surveillance (PDS).

Researchers generally agree that relying only on follow-up during admission may lead to a misinterpretation of the risks[4]. However, there are some difficulties and doubts concerning this issue. First, there is no standard reliable method for PDS. In addition, its operationalization is laborious and time-consuming. Finally, PDS may not be necessary for all surgical procedures performed in a hospital[5].

Our study aims to contribute to that discussion. We were especially concerned with the following question: *Are there any factors that may help identify a type of procedure or population for whom PDS is advised?* With that question in mind, we conducted a case-reference study to identify predictors of post-discharge-onset surgical site infections (PD-SSIs). The case-reference study was nested in a cohort of patients submitted to surgical procedures in the teaching hospital from *Faculdade de Medicina de Botucatu*. This hospital has 450 beds and is a referral hospital for an area with 500,000 inhabitants. The original cohort comprised 3,476 patients submitted to surgical procedures in six specialties: General Surgery (GS), Gastric/Intestinal Surgery (GIS), Vascular Surgery (VS), Neurological Surgery (NS), Gynecology (G) and Obstetrics (O). The specialties were defined on the basis of sharing a definite team of surgeons as there was some overlap among types of procedures (mainly between GS and GIS). The data on SSI incidence was recovered from infection control committee surveillance files for the period from July 2010 through May 2012. The SSI surveillance included daily visits during admission and telephone-based PDS, which consisted of administering a questionnaire via a telephone call for the patients 15 and 30 days after surgery. The questionnaire included the following questions: a) Did you have fever after hospital discharge? b) Was there any yellowish secretion or pus in the surgical wound? c) Was there any swelling or redness around the wound? d) Was there a delay in the healing of the surgical wound? e) Did your doctor tell you in your new consult that you had a surgical infection? and f) Was any new antibiotic prescribed for treating your wound after discharge?

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SSIs were diagnosed according to criteria from the National Healthcare Safety Network (NHSN)[6]. A patient who could not be contacted after three calls on both the 15th and 30th days was reported as *lost.*

For the case-reference study, case patients were defined as those with PD-SSI, whereas subjects with SSI diagnosed during admission were enrolled as controls. For both groups, we collected demographic data as well as information on specialties, procedure characteristics, comorbidities and immune-suppressing conditions. The burden of comorbidities was estimated using the Charlson index[7].

All data were stored in EPI INFO 3.5 (©Centers for Diseases Control and Prevention) and analyzed with Statistical Product and Service Solutions (SPSS) 19.0 (©IBM, Armonk, NY, USA). The data were initially submitted to univariate analysis. We used chi-square or Fisher's exact test for dichotomous variables, and the Mann-Whitney U test for numeric data (e.g., age in years). Multivariable analysis (logistic regression) was performed using a *change in estimate* approach for selecting variables. Briefly, all variables that reached a p-value of less than 0.2 were included in the first model. Those variables that were significant ($p < 0.05$) in this first step were then included in the second model. New analysis steps were performed, including (one by one) all the other variables (including those with p-values of greater than 0.2 in the univariate analysis). Those variables that changed the *odds ratio* of any significant variable more than 10% or reached statistical significance were included in the final model. The study was approved by the local committee for ethics in research.

We found an overall SSI incidence of 6.4%. Among the 222 SSI cases, 62.2% had onset after discharge (**Table 1**). The loss of patients for PDS was approximately 19%. However, PD-SSI predominated for all specialties except NS. This finding is in agreement with the data on the mean post-operative stay in the hospital, which was significantly higher for NS compared with other specialties (10.3 *versus* 5.2 days, $p < 0.001$).

The data from the univariate and multivariable analyses of PD-SSI predictors are presented in **Table 2**. Taking NS as a reference category, we found a greater likelihood of PD-SSI for patients from GS ($p = 0.04$) and G ($p = 0.001$) as well as for all specialties grouped together ($p = 0.03$). In contrast, patients taking steroids were more likely to develop a SSI during admission ($p = 0.01$). Notably, surgical wound classification (*clean wounds* versus other categories) was not related to PD-SSI.

Our results are worth discussing in terms of both their internal and external validity. The first issue concerns how much the results reflect the reality of the hospital where the study was conducted. A brief explanation about the specialties and their specific procedures may help elucidate this topic. Craniotomies (56.4%) and spinal surgeries (23.3%) accounted for the majority of NS procedures. They are intrinsically related to slower post-operative recovery and, therefore, a greater length of stay in the hospital. GS, G and O were on the other end of the spectrum, with mean post-operative stays of 4.0, 3.8 and 3.5 days, respectively. Briefly, the median length-of-stay (in days) for all patients from the study specialties was as follows: NS: 26; VS: 10; GIS: 8; GS: 3.5; G: 3; and O: 3.

GS is a newly instituted specialty in our hospital and includes less complicated procedures in the gastrointestinal tract, such as appendectomies, hernia repair and cholecystectomies (both traditional and laparoscopic). The GIS team perform not only the same operations but also more invasive and complex procedures, including liver and pancreas surgeries. Taken together, all these parameters argue for the internal coherence of our findings.

This leads us to the second issue, concerning external validity. Which of our findings may be valid for other hospitals? First, approximately two-thirds of the SSIs were identified after discharge, which is a noteworthy finding and is in agreement with other reports[5,8-10]. In addition, the proportion of PD-SSI varied among specialties, another finding that has been previously reported[11].

We did not identify any relationship between the wound classification (in respect to contamination) and the timing of SSI occurrence, which was surprising as contaminated and infected wounds were expected to present early SSIs[12]. Interestingly, some factors that were associated with SSI during admission in the univariate analysis (urgency/emergency procedures, multiple simultaneous operations and procedures requiring transfusion) lost their effect when included in the multivariable model.

TABLE 1 - Incidence of surgical site infections and proportion of cases with onset after hospital discharge among patients from six specialties.

Specialty	Surgical procedures	Total SSI cases	PD-SSI cases	SSI rate (%)	Proportion of PD-SSI (%)
General surgery	307	9	7	2.9	77.8
Gastric/intestinal surgery	1,106	91	55	8.2	60.4
Neurological surgery	474	23	5	4.9	21.7
Vascular surgery	294	24	13	8.2	54.2
Gynecology	617	42	38	6.8	90.5
Obstetrics	678	33	20	4.9	60.6
Total	3,476	222	138	6.4	62.2

SSI: surgical site infections; PD-SSI: post-discharge-onset surgical site infections.

TABLE 2 - Factors predictive of the post-discharge onset of surgical site infections: results from the univariate analysis and from the final model of the multivariable analysis.

	Univariate analysis				Multivariable analysis	
Predictors	PD-SSI (138)	other SSI[a] (84)	OR (95%CI)	P	OR (95%CI)	P
Demographic data						
male gender	43 (31.2)	38 (45.2)	0.55 (0.31-0.96)	0.03	0.81 (0.38-1.70)	0.57
age - median years (range)	48 (1-87)	48 (0-86)	…[b]	0.5	1.01 (0.99-1.03)[b]	0.58
Specialty						
neurological surgery - reference	5 (3.6)	18 (21.5)	1.0	…[c]	1.0	0.03[c]
general surgery	7 (5.1)	2 (2.4)	12.6 (1.97-80.76)	0.007	10.11 (1.13-90.13)	0.04
gastric/intestinal surgery	55 (39.9)	36 (42.9)	5.50 (1.88-16.13)	0.002	3.52 (0.93-13.35)	0.06
vascular surgery	13 (9.4)	11 (13.1)	4.25 (1.18-15.24)	0.03	3.09 (0.63-15.18)	0.16
gynecology	38 (27.5)	4 (4.8)	34.20 (8.19-142.82)	<0.01	15.18 (2.94-78.45)	<0.01
obstetrics	20 (14.5)	13 (15.4)	5.54 (1.65-18.63)	<0.01	3.61 (0.83-15.80)	0.09
Wound classification						
clean - reference	20 (14.5)	13 (15.5)	1.0	…[c]	1.0	0.08[c]
clean/contaminated	89 (64.5)	46 (54.8)	1.26 (0.57-2.75)	0.57	0.87 (0.32-2.35)	0.78
contaminated	15 (10.9)	18 (21.4)	0.54 (0.20-1.44)	0.37	0.33 (0.11-1.21)	0.1
dirty	14 (10.1)	7 (8.3)	1.30 (0.41-4.08)	0.65	1.81 (0.42-7.87)	0.42
Other characteristics of the procedures						
urgency/emergency	49 (35.5)	44 (52.2)	0.50 (0.29-0.87)	0.01	0.65 (0.31-1.34)	0.24
more than one surgery simultaneously	4 (2.9)	8 (9.5)	0.29 (0.08-0.97)	0.04		
blood transfusion	24 (17.4)	30 (35.7)	0.38 (0.20-0.70)	<0.01	0.70 (0.32-1.51)	0.36
Patients' comorbidities						
heart disease	2 (1.4)	2 (2.4)	0.60 (0.04-8.48)	0.48		
systemic arterial hypertension	59 (42.8)	25 (41.7)	1.05 (0.60-1.81)	0.87		
lung disease	4 (2.9)	2 (2.4)	1.22 (0.17-13.79)	0.59		
renal disease	5 (3.6)	2 (2.4)	1.54 (0.24-16.50)	0.46		
liver disease	0 (0.0)	2 (2.4)	0.0 (…[d])	0.14		
diabetes mellitus	31 (22.5)	14 (16.7)	1.45 (0.72-2.91)	0.29		
central nervous systems disease	7 (5.1)	10 (11.9)	0.39 (0.14-1.05)	0.06	0.52 (0.14-1.87)	0.31
solid malignancy	25 (18.1)	16 (19.0)	0.94 (0.47-1.88)	0.86		
malnourishment[e]	5 (3.6)	0 (0.0)	…[d]	0.09		
obesity	28 (20.2)	15 (17.9)	1.17 (0.58-2.35)	0.65		
Other characteristics of the patients						
use of steroids during admission	2 (1.4)	13 (15.5)	0.08 (0.02-0.37)	< 0.001	0.11 (0.02-0.59)	0.01
smoking	48 (34.8)	31 (36.9)	0.91 (0.51-1.60)	0.75		
alcoholism[e]	7 (5.1)	10 (11.7)	0.39 (0.04-1.08)	0.06		

SSI: surgical site infections; PD-SSI: post-discharge-surgical site infections; OR: odds ratio; CI: confidence interval; [a]all SSIs with onset during admission; [b]in the univariate analysis, age was compared for the study groups using the Mann-Whitney U test. In the multivariable analysis, age was included in the models as a continuous variable, and thus the OR represents the increase in the odds of post-discharge diagnosis per increase in *age* unit; [c]all the classes are compared with the reference. The OR for the reference category in the logistic regression refers to the difference between this category and all the others grouped; [d]OR and CI could not be calculated as one of the categories had *zero* value; [e]reported in medical files. Note: all data are on number (%), unless otherwise specified.

In contrast, the use of steroids during admission was a consistent predictor for the diagnosis of SSI during hospital stay, which was a puzzling finding. One could presume that steroids were an indirect marker of comorbidities. However, their use remained a significant predictor, even in multivariable models that included comorbidities. Another interpretation would suggest a specialty bias because steroids are often prescribed for neurological patients. Nevertheless, steroids were a significant factor after multivariable adjustment for specialties, a finding that highlights the value of steroid use as an independent predictor of the in-hospital diagnosis of SSI. Finally, we could infer that the immune-suppressing effect of steroids accelerated the manifestation of the SSI. Although this hypothesis is attractive, there is little evidence of the impact of steroids on the incidence of overall SSIs[3,13].

Other results from the multivariable analysis reinforced the relationship between the surgical specialties and the likelihood of PD-SSI. The final model strongly indicates that there are outliers on both sides. As expected, NS differed from all specialties in the tendency towards SSI manifestation during admission. GS and G were on the opposite end of the spectrum. The practical interpretation of these findings is that although PDS is not necessary for NS patients, it is strongly advised for GS and G patients.

The external validity of our findings obviously depends on how closely the characteristics of those specialties in other hospitals resemble ours. However, even if there is not a strong resemblance, the validity of the method remains. In other words, an analysis similar to that reported here should be performed in other healthcare settings to provide a guide for decisions about PDS policies.

Some limits of our analysis must be stressed. First, we have not assessed all the surgical specialties of our hospital. Orthopedics, cardiac surgery and urologic surgery – to name just a few – were not included in the present study because PDS was not routinely performed for those specialties during the study period. In addition, the classic *National Nosocomial Infection Surveillance* index for SSI risk was not included in our analysis because the surgical data required for its calculation were not reliable for all specialties. The major limitations of our study are related to the choice of a telephone-based PDS. Although we strictly attempted to follow the NHSN definitions, we cannot assure that the accuracy of telephone diagnosis is similar to that obtained in a clinical examination. Nevertheless, telephone-based surveillance is widely used because alternative methods are either not sensitive or too laborious and costly[14]. We must stress that neither this nor any other strategy for PDS has been adequately validated[15].

Our study also has methodological strengths. The original cohort of patients was large enough to provide a number of cases and controls sufficient for providing power to the statistical analysis. In addition, we aimed at analyzing as many confounders as possible, while not including the study variables that were not reliable. The *change in estimate* method employed for the multivariable analysis allowed us to test the individual effect of each variable on the significant predictors[9].

In conclusion, our study supports the usefulness of a specialty-based PDS. Although parameters may vary in different hospitals, an analysis similar to ours may guide the infection control team to develop rational PDS policies that prevent the underreporting of infections.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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