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## Major Article

## Improving compliance with surgical antibiotic prophylaxis guidelines: A multicenter evaluation



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## Key Words:

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**Background:** Improving surgical antibiotic prophylaxis (SAP) use is an important element in the control of antimicrobial resistance. However, compliance with SAP guidelines is unsatisfactory. This study investigated the level of compliance with SAP guidelines in neurosurgery, and institutional characteristics associated with compliance.

**Methods:** This study assessed surgeries in 9 Brazilian hospitals. Medical record reviews and a structured questionnaire were used to assess compliance and to describe institutional characteristics. Six attributes of compliance with SAP guidelines were evaluated; full compliance was defined whenever all these attributes were met. Logistic and linear regressions were used to investigate the association between compliance, patients, and hospital characteristics.

**Results:** Full compliance was 10% and was associated with weekly hours of infection control personnel per intensive care unit bed (95% CI, 0.2–0.1), hospital-wide dissemination of SAP guidelines (95% CI, 1.2–25.1), monitoring (95% CI, 1.2–25.1), and feedback of compliance rates (95% CI, 3.8–25.2). Daytime procedures had greater compliance regarding drug dose (odds ratio [OR], 3.38; 95% confidence interval [CI], 1.72–6.65) and initial time (OR, 2.30; 95% CI, 1.24–4.25). Spinal procedures achieved greater compliance with initial time (OR, 1.83; 95% CI, 1.12–3.01) and duration (OR, 1.59; 95% CI, 1.7–2.16).

**Conclusions:** A low level of compliance was identified, which pointed out the need for an innovative stewardship approach to improve adherence to SAP guidelines. Targeted training programs need to be developed to ensure dissemination of guidelines among surgeons. Monitoring, feedback, and closer interaction between the infection control personnel and the surgical team are key factors for better compliance rates of SAP.

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Surgical site infections (SSIs) are among the major surgical complications and account for approximately 20% of all health care-associated infections (HAIs).<sup>1</sup> These infections increase the length of hospital stay from 7 to 11 days, double the risk of postsurgical death, and account for over one-third of the HAI treatment costs.<sup>2</sup>

The estimation of the SSI rate related to skull and spine procedures varies from 1.07%–1.51% and from 0.58%–2.04%, respectively. Two meta-analyses found that appropriate usage of surgical antibiotic prophylaxis (SAP) significantly reduced the risk of SSI related

to skull and spine surgery (odds ratio [OR], 0.43; 95% confidence interval [CI], 0.20–0.92<sup>3</sup> and OR, 0.37; 95% CI, 0.17–0.78<sup>4</sup>), respectively.

Inadequate SAP usage increases SSI, increases hospital costs, and fosters the emergence of multidrug-resistant strains.<sup>5–8</sup> Antimicrobial resistance is a global public health threat that has as one of the main causes the massive overuse of antibiotics. In Europe, the prevalence of hospital antibiotic use is 35%.<sup>9</sup> Over 10% of these prescriptions are destined for SAP,<sup>9</sup> and more than half of antibiotics are inadequately maintained for >1 day.<sup>9</sup> In developing countries, the problem may be even more serious. Research conducted in Africa found that >99% of surgical patients received the first dose of SAP after the end of the surgical procedure,<sup>10</sup> whereas a Brazilian study showed only 4.9% of surgical procedures in compliance with local SAP guidelines.<sup>11</sup> Nevertheless, there is little information on the appropriate use of antimicrobials for surgical patients in developing countries.

Improving SAP use is an important element in the control of microbial resistance by preventing the selective pressure exerted by

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antimicrobial misuse. The design of effective SAP improvement strategies needs to be based on the understanding of the factors that are associated with compliance. Hence, observational studies might be the first step toward implementation of programs to achieve higher levels of SAP compliance.

Local evidence-based guidelines are essential to promote the correct use of SAP. However, the sole existence of SAP guidelines does not ensure compliance.<sup>12,13</sup> In a previous study, we identified failures in the effective application of institutional guidelines.<sup>11</sup> Despite the profusion of literature about the subject,<sup>5-8,14</sup> few studies have been undertaken addressing factors associated with better SAP compliance and, particularly, regarding SAP use in neurosurgery.<sup>8,11,15</sup> This study aims to determine the index of SAP compliance in neurosurgery and to identify institutional characteristics associated with better compliance.

## MATERIALS AND METHODS

### Study design

A retrospective cross-sectional study was carried out involving 9 tertiary care hospitals, public and private, located in São Paulo city, Brazil. São Paulo, the largest city in the Americas, with approximately 11 million inhabitants, has 148 general hospitals according to the national register of hospitals at the time of the project design (<http://cnes.datasus.gov.br>).

### Settings and sampling

The inclusion criteria for hospitals were defined as follows: at least 100 procedures of neurosurgery performed in 2010 and having medical records of adult ( $\geq 18$  years) neurosurgical patients submitted to clean surgical procedures for which SAP was indicated, involving the skull or spine. All the 31 hospitals that met these criteria were invited to participate. The invitation was carried out by telephone contact directly to members of the hospital infection control committees (HICCs). Nine hospitals accepted the invitation and were included in the sample. The sample size for medical records within each hospital was calculated based on the total number of procedures performed in the facility in 2010, with an expected compliance rate of 40%, resulting in a sample of 1,459 clean surgical procedures to be assessed. The medical records were randomly selected by using a randomization table. Procedures for hospital selection and invitation, ethical approvals, and sampling were performed between 2011 and 2012.

### Data collection

Data collection was performed by the principal investigator (C.S.) and by 3 trained nurses from August 2013-September 2014. The year of 2010 was used as the reference for data collection. Compliance was defined as the agreement of procedures to SAP guidelines available at the hospital. The assessment of compliance focused on the effective application of institutional SAP guidelines, with no attempts to evaluate the quality of institutional guidelines. Only SAP guidelines formally approved by the HICC were considered. Data regarding SAP compliance, patient characteristics (age, sex, and American Society of Anesthesiologists score), type of procedure, time of procedure (day or night), day of the week (weekday or weekend), and duration of procedure were gathered from the medical records of neurosurgical patients.

The assessment of compliance with SAP was composed of 6 attributes, which were checked against each HICC internal guideline: (1) the appropriate indication of antibiotic, (2) the drug type, (3) the duration of prophylaxis (ie, the time from the first dose to

the last one), (4) the administration route, (5) the initial time of antibiotic prophylaxis (administration within 60 minutes of surgical incision), and (6) the drug dosage. A full compliance index was met only when all 6 attributes of SAP were compliant with the respective HICC guidelines, resulting in a dichotomous outcome: compliance or noncompliance.

A structured questionnaire was applied to the HICC members by means of an interview to access institutional characteristics regarding overall number of beds, intensive care unit (ICU) beds, type of funding (public or private), and the existence of any external quality accreditation. The HICC members interviewed were designated by the hospital administration. The HICC was characterized according to time length of its establishment, number of dedicated professionals and their formal education, and weekly working hours. The existence of established guidelines, frequency of their updating, dissemination strategies, frequency of SAP training sessions, and existence of outcome and process indicators regarding SSI rate and compliance with SAP protocols were investigated.

### Data analysis

A logistic regression was carried out to analyze the association between compliance with SAP attributes (dichotomous outcome variables) and the characteristics of surgical procedures. The association between hospital characteristics and SAP compliance index (continuous outcome variables) was assessed through linear regression. For both linear and logistic regression, the associations were adjusted for all variables in the model accordingly. All analyses were conducted assuming a CI of 95% using Stata 12.0 (Stata Corp., Brownsville, TX).

### Ethics

The research was approved by the Ethics in Research Committee of the School of Nursing, University of Sao Paulo (protocol no. 73611) and by the ethics committee of each hospital.

## RESULTS

### Institutional characteristics

Nine hospitals with capacities between 156 and 800 beds were evaluated; among them, 6 were private and 3 were public settings. Five hospitals had quality certification by an external board of evaluation. The average time of establishment of the HICC was 21.9 years (range, 10-39). All hospitals had at least 1 physician and 1 nurse dedicated to the HICC. The mean weekly working hours of HICC-dedicated personnel per bed was 0.5 hours (range, 0.2-0.9 hours), and per ICU bed was 2.9 hours (range, 1.2-6.0 hours).

The 9 evaluated hospitals performed 3,253 neurosurgical procedures in 2010. The number of neurosurgical procedures ranged from 138-1,057, with a mean of 361. A total of 1,011 surgical procedures were assessed, including 451 (44.6%) craniotomies, 325 (32.1%) spinal fusions, 196 (19.4%) laminectomies, and 39 (3.9%) other procedures. Slightly more than half of the patients were men (50.5%), with a mean age of 50 years (range, 18-94 years).

All hospitals had SSI prevention guidelines, which were updated at least every 1-2 years. The guidelines showed variations among the evaluated hospitals. Most of the guidelines recommended second-generation cephalosporins. However, recommendations of third-generation cephalosporins or glycopeptides for patients with long-term hospitalization ( $\geq 5$  days) were identified. Duration of SAP ranged from a single dose up to 5 days. In 6 hospitals, the HICC team stated that guidelines were hospital-wide disseminated, promoting that nearly all professionals knew the institutional guidelines. The guidelines were available in hard copies, digital format, or both

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