Discontinuation of Postoperative Prophylactic Antibiotics After Noninstrumented Spinal Surgery: Results of a Quality Improvement Project

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Abstract

Background: Numerous medical society guidelines recommend discontinuation of antibiotics at a maximum of 24 hours after noninstrumented spinal surgery, even when a drain is left in place. As a result of these recommendations, our institution's Neurosurgery Quality Improvement Committee decided to stop administering prolonged prophylactic systemic antibiotics (PPSAs) to patients with drains after noninstrumented spinal surgery. **Methods:** We retrospectively reviewed data for patients who had noninstrumented spinal surgery performed by a neurosurgeon at our institution between December 2012 and July 2014 (PPSA period) and December 2014 and July 2016 (non-PPSA period) and had a drain left in place postoperatively. In the PPSA period, patients received antibiotics until drain removal. In the non-PPSA period, patients received antibiotics for a maximum of 24 hours. **Results:** We identified 58 patients in the PPSA period and 55 in the non-PPSA period. Discontinuation of PPSAs resulted in a nonsignificant increase in the frequency of surgical site infections (SSIs; 0% in the PPSA period vs 4% in the non-PPSA period; $P = .24$). **Conclusion:** After discontinuing PPSAs for patients with noninstrumented spinal procedures, as is recommended for quality improvement, we saw a nonsignificant increase in our rate of SSIs. Further monitoring of this population is warranted.

Keywords

neurocritical care, surgical site infection, postoperative infection, spine, prophylactic antibiotics

Introduction

Prolonged prophylactic systemic antibiotics (PPSAs) are often administered to patients with neurosurgical drains and devices to prevent surgical site infections (SSIs).¹⁻³ Although this goal is laudable, PPSA use can actually harm patients by increasing the risk of development of *Clostridium difficile* infections (CDIs)^{2,4} and growth of resistant bacteria.^{1,5} These complications are not trivial.^{6,7} Furthermore, because antibiotics can change an institution's flora, the use of PPSAs can have a wide-ranging impact on hospitalized patients.^{5,8}

Because of these complications, the Neurosurgery Quality Improvement Committee at our institution revised our antibiotic prophylaxis protocol such that patients with subdural drains, subgaleal drains, or spinal drains after non-instrumented procedures are no longer given PPSAs. We previously reviewed the results of discontinuing PPSAs for patients with subdural and subgaleal drains and found that this change was not associated with an increase in the frequency of SSIs, but it was actually associated with a

decrease in the frequency of CDIs and growth of resistant bacteria.⁹

In the present analysis, we retrospectively evaluated the consequences of our new protocol by reviewing the rates of SSIs, CDIs, and growth of resistant bacteria in patients with drains after noninstrumented spinal procedures, and the savings associated with discontinuation of PPSAs.

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Methods

Antibiotic Prophylaxis Protocol

Before October 2014, all patients who had noninstrumented spinal surgery with a neurosurgeon at NYU Langone Medical Center and had a drain left in place postoperatively were given PPSAs (cefazolin or vancomycin if cefazolin was contraindicated) until the drain was removed. In October 2014, our institutional protocol was revised such that prophylactic antibiotics were discontinued a maximum of 24 hours after non-instrumented spinal surgery, regardless of whether or not a drain was left in place. No other changes were made to infection prevention practices including the use of nasal mupirocin for patients positive for methicillin-resistant *Staphylococcus aureus*, chlorhexidine to prep, drapes to isolate the surgical site, and topical antibiotics at the discretion of the surgeon. All patients undergoing noninstrumented spinal surgery continued to receive at least 1 dose of antibiotics intraoperatively within 1 hour of incision. The neurosurgeons who performed spinal procedures remained the same before and after the policy revision. Drains were removed at the discretion of the surgeon who performed the procedure.

Patient Selection/Data Collection

Data were extracted from a retrospective quality improvement database. Patients were included if they were over the age of 17 and had noninstrumented spinal surgery performed by a neurosurgeon at our institution between December 2012 and July 2014 (PPSA period) and December 2014 and July 2016 (non-PPSA period) and had a drain left in place postoperatively (these dates were selected to allow for a washout period before and after the protocol revision). Patients were excluded if they had prior instrumentation at the level of the surgery, any other type of drain (e.g., chest tube, lumbar drain), or known preoperative spinal infections (e.g., abscess, osteomyelitis). Patients from the non-PPSA period who were given PPSA for more than 24 hours were included in the PPSA group and charted as protocol deviations. Patients who received prophylactic antibiotics other than cefazolin or vancomycin were also charted as protocol deviations but were included in the PPSA or non-PPSA periods accordingly based upon the duration of antibiotics.

The database included information about demographics, drains, postoperative antibiotics (intraoperative antibiotics were not included in the database), and microbiology results for 90 days after drain placement. Deep and superficial SSIs were defined using Centers for Disease Control criteria. A deep SSI is present if a patient has 1 or more of the following: (1) purulent drainage from a deep incision; (2) an incision that dehisces or is intentionally debrided and is culture positive or not cultured and is associated with fever $>38^{\circ}\text{C}$ or localized pain; (3) an abscess at the surgical site. A superficial SSI is present if a patient has one or more of the following: (1) purulent drainage from a superficial incision; (2) organisms isolated from a culture of a superficial incision; (3) an incision

that was debrided and is culture positive or not cultured and is associated with pain, swelling, redness, or heat.¹⁰ Growth of resistant organisms was defined as growth of an organism that was resistant to the intravenous antibiotic used for prophylaxis (cefazolin or vancomycin). If no systemic antibiotic was used postoperatively for prophylaxis, we broadly defined a resistant organism as an organism resistant to cefazolin or vancomycin.

Cost Calculations

Cost savings for antibiotics were calculated based on the cost of a 1-g bag of cefazolin (US\$3.29) and a 1-g vial of vancomycin (US\$3.10) at our institution.

Data Evaluation

Data were analyzed using descriptive statistics, Fisher exact test, likelihood ratio, and Mann Whitney *U* test as appropriate. All statistical analyses were performed using SPSS 21. A *P* value of .05 was considered statistically significant. This study was approved by the Institutional Review Board at NYU Langone Medical Center. A waiver of informed consent was granted.

Results

There were 58 patients who met inclusion criteria in the period with PPSAs and 55 in the period without PPSAs. See Table 1 for demographic data. Degenerative disc disease was more prevalent as the primary diagnosis in the non-PPSA cohort. The median number of drains in both groups was 1 and the median number of drain days was similar (PPSA 4 vs non-PPSA 3, *P* = .31; Mann Whitney *U* test). There were 5 protocol deviations (see Table 2).

During the PPSA period, a total of 317 doses of cefazolin and 84 doses of vancomycin were administered for drain prophylaxis, which amounted to a cost of US\$1303.33. In the non-PPSA period, only 19 doses of cefazolin and 2 doses of vancomycin were administered for drain prophylaxis, which amounted to a cost of US\$68.71.

The infection data are summarized in Table 3. During the PPSA period, the incidence of SSIs was 0%. In the non-PPSA period, the incidence of SSIs was 4% (2 of 55 patients). The difference in infection rates was not statistically significant (*P* = .24; Fisher exact test). During the PPSA period, 1 patient grew a resistant organism. After discontinuation of PPSAs, 2 patients grew resistant organisms. There were no cases of CDIs during either period. See Table 4 for details on the patients who developed SSIs or grew resistant organisms.

Discussion

Numerous medical organizations have recommended the limitation of prophylactic antibiotic use postoperatively.¹¹⁻¹⁴ The World Health Organization recommends that antibiotic prophylaxis not be continued postoperatively, even when a drain is left in place.¹³ Clinical practice guidelines published by the

Table 1. Demographic Data.

	Patients Who Received PPSAs (n = 58)	Patients Who Did Not Received PPSAs (n = 55)	P Value
Male, n (%)	27 (47%)	30 (55%)	.45 ^a
Age, median (IQR)	65 (53-71)	65 (50-73)	.83 ^b
Number of hospital days, median (IQR)	4 (3-5)	3 (2-5)	.39 ^b
Primary diagnosis			.009 ^c
Bleed, n (%)	1 (2%)	0 (0%)	
Degenerative disc disease, n (%)	29 (50%)	42 (76%)	
Tumor—benign, n (%)	14 (24%)	9 (16%)	
Tumor—malignant, n (%)	7 (12%)	4 (7%)	
Vascular lesion, n (%)	6 (10%)	0 (0%)	
Other, n (%)	1 (2%)	0 (0%)	
Drain data			
Number of drains, median (IQR)	1 (1-2)	1 (1-2)	.59 ^b
Number of drain days, median (IQR)	4 (3-4)	3 (3-4)	.31 ^b
Prophylaxis			
Cefazolin doses, total	317	19	
Vancomycin doses, total	84	2	

Abbreviations: IQR, interquartile range; PPSAs, prolonged prophylactic systemic antibiotics.

^aFisher exact test.

^bMann Whitney U test.

^cLikelihood ratio.

Table 2. Demographic Data for Patients With Protocol Deviations.^a

	1	2	3	4	5
Date	May 2013	December 2013	March 2015	March 2015	July 2016
Sex	Male	Male	Male	Female	Female
Age	68	75	70	70	80
Number of hospital days	3	3	3	2	1
Primary diagnosis	Degenerative disc disease	Tumor—benign	Degenerative disc disease	Degenerative disc disease	Degenerative disc disease
Number of drains	1	2	1	1	1
Number of drain days	4	3	3	2	2
Protocol deviation	One dose of daptomycin given in addition to 6 doses of vancomycin	Two doses of gentamicin given in addition to 4 doses of vancomycin	Prophylactic antibiotics given for greater than 24 hours (9 doses of cefazolin) ^b	Prophylactic antibiotics given for greater than 24 hours (6 doses of cefazolin) ^b	One dose of ceftriaxone given instead of cefazolin/vancomycin
Explanation	No explanation provided	No explanation provided	No explanation provided	No explanation provided	No explanation provided

Abbreviation: PPSAs, prolonged prophylactic systemic antibiotics.

^aThese deviations were made by 4 different attending neurosurgeons.

^bThese patients were included in the PPSA period.

American Society of Health-System Pharmacists, the Infectious Diseases Society of America, the Surgical Infection Society, and the Society for Healthcare Epidemiology of America on peri- and postoperative use of antibiotics state that patients getting spinal procedures with or without instrumentation should be given cefazolin (with alternatives of clindamycin or vancomycin) preoperatively and for a maximum of 24 hours postoperatively. The guidelines note that there is no data to support continuation of antibiotics until all drains and devices

are removed.¹⁴ The British Society for Antimicrobial Chemotherapy Working Party for Neurosurgical Infections also found that there is insufficient evidence to support the use of PPSAs for coverage of lines, drains, or catheters postoperatively after spinal procedures.^{11,12} Despite these recommendations, a survey of the Neurocritical Care Society found that 33% of respondents reported PPSAs were administered to patients who had postoperative drains after noninstrumented spinal surgery at their institution.³ Notably, the North American Spine

Table 3. Infections.

	Patients Who Received PPSAs (n = 58)	Patients Who Did Not Receive PPSAs (n = 55)	P Value
Surgical site infections	0 (0%)	2 (4%)	.24 ^a
Deep infections, n (%)	0 (0%)	1 (2%)	.49 ^a
Superficial infections, n (%)	0 (0%)	1 (2%)	.49 ^a
Growth of a resistant organism	1 (2%)	2 (4%)	.61 ^a
Growth of a blood culture, n (%)	1 (2%)	1 (2%)	1 ^a
Growth of a resistant organism in blood, n (%)	1 (2%)	0 (0%)	1 ^a
Growth of a urine culture, n (%)	4 (7%)	5 (9%)	.74 ^a
Growth of a resistant organism in urine, n (%)	0 (0%)	2 (4%)	.24 ^a
Growth of a CSF culture, n (%)	0 (0%)	0 (0%)	—
Growth of a sputum culture, n (%)	0 (0%)	0 (0%)	—
<i>Clostridium difficile</i>	0 (0%)	0 (0%)	—

Abbreviations: CSF, cerebrospinal fluid; PPSAs, prolonged prophylactic systemic antibiotics.

^aFisher exact test.

Table 4. Characteristics of Patients With Surgical Site Infections, *Clostridium difficile*, or Resistant Organisms Within 90 Days of Drain Placement.

Infection	Age	Sex	Primary Diagnosis	Drain Days	PPSAs	Topical Antibiotics ^a	Number of Days Between Drain Placement and Infection
Deep SSI: MRSA	69	F	Degenerative disc disease	3	No	No	23
Superficial SSI: No organism	64	M	Degenerative disc disease	4	No	Yes	5
Growth of coagulase-negative <i>Staphylococcus</i> in blood resistant to cefazolin	56	F	Tumor-malignant	2	Yes	—	57
Growth of <i>Klebsiella pneumoniae</i> in urine resistant to cefazolin	54	F	Tumor-malignant	4	No	—	13
Growth of <i>Escherichia coli</i> in urine resistant to cefazolin	72	M	Degenerative disc disease	2	No	—	54

Abbreviations: F, female; M, male; MRSA, methicillin-resistant *Staphylococcus aureus*; PPSAs, prolonged prophylactic systemic antibiotics; SSI, surgical site infection.

^aData on topical antibiotic administration was only collected for surgical site infections.

Society guidelines on antibiotic prophylaxis state that there is insufficient evidence to make a recommendation for or against discontinuation of antibiotic prophylaxis for patients with post-operative drains 24 hours after surgery. They recommend a prospective controlled study comparing infection rates with and without PPSAs.¹⁵ It is estimated that 2000 to 5036 patients would be required for such a study.¹¹

The reported incidence of infection after spinal surgery is variable and ranges from 0.1% to 20%.^{16,17} The North American Spine Society notes that despite appropriate antibiotic prophylaxis, the expected rate of SSIs after spine surgery is 0.7% to 10%, and acknowledges that the current best practice protocols fail to completely eliminate SSIs.¹⁵ Our infection rate was 0% in the PPSA period and 4% in the non-PPSA period. Though there was no significant difference in these rates, our target is of course to eliminate SSIs completely. We will certainly continue to monitor our infection rates going forward, but we will not allow these findings from a small cohort to propel us to thwart established guidelines and reinitiate the use of PPSAs.¹¹⁻¹⁴

Antibiotics are important for infection prevention, but because they can lead to significant complications, both for the patient receiving them and for all concurrently hospitalized patients, they cannot be administered indiscriminately and instead need to be prescribed rationally.^{1,2,4,5,8} Although our findings did not demonstrate an increase in CDIs during the PPSA period, this is a well-established, serious complication associated with antibiotic usage.^{2,4,6} Growth of resistant bacteria is another known complication of PPSA use.^{1,5} Interestingly, we found that more resistant organisms grew in the non-PPSA period than in the PPSA period (2 resistant urinary tract infections in the non-PPSA period vs 1 resistant bacteremia in the PPSA period). This reflects the fact that antibiotic resistance in both health-care systems and the community is a growing problem due to high volumes of antimicrobials and spread of resistant microorganisms and genes encoding for resistance. It is also important to note that even when antibiotics are administered for 24 hours or less, they place patients at risk for growth of resistant organisms.¹⁸ Additionally, our

assessment of growth of resistant organisms was limited to clinical isolates, so it is possible that other patients grew resistant organisms and these data were not captured because there was no clinical indication to check cultures.

A nationwide epidemiological study in the United States found that 50% of hospitalized patients were on antibiotics, and 12% of these patients were receiving them for surgical prophylaxis. Of the 52 patients in neurocritical care units, 40% were receiving antibiotics.¹⁹ Nationally, the Centers for Disease Control and the Joint Commission are working to regulate the use of antibiotics to improve monitoring and reporting of inpatient antimicrobial use.^{20,21} It is important to avoid reliance on anecdotal evidence about antibiotic use and develop local antibiotic prophylaxis protocols, as these are more likely to be followed than national and societal guidelines.^{3,8,22}

Instead of using PPSAs, surgeons can minimize the rates of SSIs through optimization of preoperative preparation, surgical technique, perioperative antibiotic prophylaxis, and postoperative wound care.⁸ Use of topical antibiotics during noninstrumented spinal surgery is controversial,^{12,23} and this practice is not routinely used at our institution. However, despite a surgeon's best efforts to minimize risks of SSIs, it is important to note that some patients have comorbidities such as diabetes, obesity, neurologic deficits, incontinence, rheumatoid arthritis, tobacco use, and poor nutrition that increase their risks of SSI.^{11,15}

Limitations

Our findings represent a single-institution experience. The number of cases in both groups was small. Our institution performs 800 to 900 spinal surgeries annually, but noninstrumented cases are rare. This is representative of the national downward trend in the frequency of noninstrumented spinal surgery.²⁴ Of note, in 2016, our Neurosurgery Quality Improvement Committee elected to discontinue PPSAs for patients with drains after instrumented spinal cases, and we reviewed the infection rates for this group separately.²⁵ Additionally, there was a difference in the distribution of principal diagnoses between cohorts, but we do not think this biased our results because SSIs did not cluster within a single principal diagnosis. Although our database did not include information regarding compliance with our routine infection prevention procedures, it would be necessary to record these data in a prospective evaluation to ensure standardization.

It is feasible that patients developed SSIs or CDIs or grew resistant bacteria postoperatively and presented to another institution, and that these data were not part of our medical records. However, we expect these patients would ultimately follow-up with the surgeon who performed their procedure, so it is unlikely that any SSIs, CDIs, or resistant bacterial infections were missed.

Conclusion

Although numerous guidelines recommend discontinuation of antibiotics 24 hours after noninstrumented spine

surgery even when drains are left in place, we found that there was a nonsignificant increase in our SSI rate when we stopped PPSAs. Further monitoring of this population is warranted.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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