Compliance of Perioperative Antibiotic Dosing and Surgical Site Infection Rate in Office-Based Elective Surgery

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Background: A best practice goal to reduce surgical site infection includes administration of antibiotics in the ideal preoperative window. This article evaluates an office surgical suite antibiotic administration rate and compares it with the timing of a local hospital treating a similar patient population. The hypothesis was that similar or better compliance and surgical site infection rates can be achieved in the office-based suite.
Methods: A total of 277 office-based surgeries were analyzed for antibiotic administration time before incision and their corresponding surgical site infection rate.
Results: Our facility administered timely prophylactic antibiotics in 96% of cases with a surgical site infection rate of 0.36%. This rate was significantly lower than a reported rate of 3.7%.
Conclusion: Low infection rates with high antibiotic administration rate suggest that compliance with best possible practice protocols is possible in the outpatient setting. *(Plast Reconstr Surg Glob Open 2016;4:e710; doi: 10.1097/GOX.0000000000000704; Published online 19 May 2016.)*

Prophylactic antibiotic administration is one of the many recommended guidelines to prevent surgical site infections (SSIs)[1–15]; however, data on its effectiveness in outpatient elective surgery are lacking.[9,10,11] There are also conflicting data on when to administer antibiotics within the time range.[1–10] In general, preventive antibiotic administration within 60 minutes of incision has shown to be an effective means of reducing nosocomial and wound infections.[7]

The types of infections that are seen in plastic surgery are grouped into superficial versus deep incisional, because intracavity is rarely encountered. Both infections occur within 30 days of the operation. The superficial infection has purulent drainage from superficial incision, organisms isolated from a fluid or tissue culture, and/or 1 of the following—pain/tenderness, localized swelling redness, or heat. The deep SSI is indicated by purulent drainage, dehiscence or open wound with a fever (>38°C), localized pain, tenderness, or an abscess.[1–3] The placement of foreign bodies, such as implants, increases the risk of infection through local contamination and biofilm formation, which extends monitoring to 1 year after operation.[1]

Although there are varying opinions on the need for prophylactic antibiotics during simple clean procedures, there is a general consensus concerning the use of prophylactic antibiotics during clean-contaminated procedures, as well as elective clean procedures using a medical implant. In addition, this protocol is followed to meet standards for facil-

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ity accreditation. The Surgical Care Improvement Project established a core measure set for infection prevention, which includes administration of antibiotic within 1 hour before incision, careful selection of the antibiotic for the patient, and discontinuation of prophylactic antibiotics within 24 hours after surgery.[4,7,8,16] Antibiotic dosage and selection reflects the protocol from the American Society of Health-System Pharmacists.[17]

A 2011 analysis of readmissions to hospitals after outpatient cosmetic surgery from the National Surgical Quality Improvement Program database showed a 0.90% readmission rate, of which 19.23% of patients had superficial SSI and 15.38% had deep SSI.[15] Although these data summarize elective plastic surgery infection rates in hospitals, it fails to isolate individual infection rates by procedure and to address the infection rates of office-based surgical suites. On the other spectrum, a retrospective study on SSI in the ambulatory setting failed to include plastic surgery as one of its analyzed specialties.[11] Comprehensive studies merging compliance in the ambulatory setting for elective surgery are lacking.

Although Centers for Medicare and Medicaid Services ask for antibiotic times from participatory ambulatory surgical centers, adherence is infrequent, and reporting SSI rates is not obligatory[18]; furthermore, Medicare-eligible cases, then, by definition, exclude outcomes of elective aesthetic surgery cases. These SSIs not only extend hospital stay but also lead to higher costs with readmission.[18–23]

Historically, the National Surgical Infection Prevention Project reported a 55.7% compliance rate of prophylactic antibiotics within the recommended 1 hour before incision.[24] As a focus of best practices, this has improved—a new Surgical Care Improvement Project national average of 98% has been established.[25] The national average for SSI is 1.9%.[26] The purpose of this project was to analyze whether compliance with guidelines is possible at an office-based surgery suite and to compare national compliance rates to those of the office-based surgery suite. Comparisons with similar population groups at a hospital setting were also made. The demographics of the office-based surgical suite and hospital are identical—same geographic location, socioeconomics, all adults, and equal male:female population. These national rates are for general surgery types. Beyond the lack of literature for the outpatient office-based setting, there is also a dearth of research analyzing plastic surgery-specific infection rates.

Our project focuses on the role of antibiotic prophylaxis guidelines in reducing SSI to show that, regardless of surgical setting, the same infection prevention measures can be implemented with similar high compliance and low infection rates.

METHODS

Our facility is an outpatient surgical suite accredited by the Accreditation Association for Ambulatory Health Care (AAAHC) and used solely for elective surgery in an urban, high-rent city. This project was approved by the Institutional Review Board at American University. Proper presurgical, sterile preparation protocol per AAAHC and the Association of Perioperative Registered Nurses guidelines was followed for each surgery. There is 1 operating room that averages 200 surgical procedures per year. We used data from a neighbor hospital with whom our facility has a transfer agreement, as well as a similar surgical patient population to compare with our data.

Data analysis was both qualitative and quantitative in nature. The intraoperative reports and longitudinal electronic records over 24 months of the most recent 277 consecutive patients from 2011 to 2013 were analyzed from an AAAHC-certified single operating room office-based surgery suite by the research assistant. In cases in which implantable devices were used, this was extended to 1 year.

Basic statistical methods were used to determine the sample size for a proportions test[27] based on a 95% confidence interval with a margin of error of 3%. Times of OR entry, antibiotic administration, and incision were recorded and compared with any new signs of infection. Data analysis was retrospective. Data collected were as follows: (1) antibiotic administration time, (2) cut time, (3) difference between antibiotic to cut time, (4) SSI, and (5) SSI rate.

We calculated a 95% confidence interval for the sample population of 277 patients who received antibiotics within 1 hour before incision. Those without recorded times were removed from the sample. The 95% confidence interval for the patients who received antibiotics after incision was calculated as above 1 hour.

We hypothesized that our antibiotic administration rate was higher than the historical 55.7% national average and equal to that of the best practices 98%. We also hypothesized that our infection rate was less than the 1.9% national average at a 0.05 significance level. We compared the local hospital's data[28,29] for administration compliance and SSI rate (Table 1) with that of our facility's by using the large-sample method.[27] As the reconstructive or overnight cosmetic patients from the practice are also operated at this hospital, it was used as a control. Furthermore, the same anesthesiologists and perioperative

Table 1. 2013 Comparison of Our Facility's Surgical Site Infection with Those of a Local Hospital

Measure of Success	Hospital Year to Date	Office Year to Date
Total number of surgeries	11,373	277
SSI (includes all surgical procedures)	27	1
SSI rate	0.24	0.36

This table shows the surgical site infection rates contributed from a local regional hospital compared with the rates from our office. The information contained in this document is based on the results of peer review activities. Therefore, this document and any of the attachments are subject to certain privilege(s) and protected by state peer review and internal risk management program laws and federal protections afforded by the Health Care Quality Improvement Act of 1986, Public Law 99–660. Not for use in litigation.

antibiotics are used at both the hospital and the office facility.

A 1-sided significance test was used to compare our specific surgery infection rates versus the corresponding national infection rates by the respective categories at the 0.05 level. The categories considered were breast augmentation, breast reduction, abdominoplasty, and rhinoplasty. Rates are outlined by Hsu et al[26] and were assigned in Table 2 to their corresponding surgery types—clean versus clean-contaminated in elective surgery. A national plastic surgery infection rate was extrapolated based on the surgery types listed in Table 2 to give us the 3.675 rate used.

All analysis was performed using SPSS (IBM Corp., Armonk, N.Y.). Patients were identified and analyzed by their already assigned and randomly generated ID number using NexTech Medical Practice Software (Nextech Systems LLC, Tampa, Fla.) and remained anonymous during data analysis. All data were gathered electronically and stored in the patient's medical file, which is encrypted for all patients. Health Insurance Portability and Accountability Act guidelines were followed. This office-based suite is accredited by the AAAHC, a nonprofit organization that sets standards for quality patient care based on education, research, and peer review. The Association of Perioperative Registered Nurses guidelines for surgical site preparation were followed.[30]

RESULTS

The average time between antibiotic prophylaxis administration and incision was 15.095 minutes. Records show that 7 patients received prophylaxis after incision time. Four of the 277 operative reports analyzed showed no documentation of prophylaxis (Table 3); however, these 4 patients had no noted infections postoperatively. The SSI rate was calculated to be 0.36% for 1 case; of note is that this patient was at a high risk for infection because it was the patient's sixth revisionary clean-contaminated rhinoplasty surgery.

The resulting 95% confidence interval comparing the national average of antibiotic administration within an hour of surgery was 92.6% to 97.5%. Results show a statistically significant difference and indicate a P value <0.0001. Our facility's compliance of administering antibiotics within 1 hour is higher than the national Medicare average. We compared our administration of antibiotics and SSI rate (0.36%) with that of the local hospital (0.26%), resulting in large P values (0.961 and

Table 2. Comparison of Plastic Surgery-Specific Infection Rates between Our Facility and Hsu et al[26]

Surgery	OBSS Cases	OBSS Infections	OBSS Rates (%)	Hsu Et al.'s Rates (%)
Breast augmentation	69	0	0	0
Breast reduction	41	0	0	8.5
Abdominoplasty	30	0	0	7.3
Rhinoplasty	30	1	3.3	8.9

This table compares the rates of infection in the office-based surgical suite with those summarized by Hsu et al[26] for the same types of surgeries. These are elective surgery-specific rates, illustrating our facility's infection rate.

Table 3. Perioperative Antibiotic Type and Dose Used by Caseload with Postoperative Surgical Site Infection Occurrence Explained

Perioperative Antibiotic	Cases Receiving Antibiotic	Postoperative Infection	Procedure with Infection	Result
1 g Ancef	266	1	rhinoplasty with rib graft	20-day Bactroban*
2 g Ancef	4	0	n/a	N/A
400 g Cipro	1	0	n/a	N/A
600 mg clindamycin	6	0	n/a	N/A

This table outlines the only (superficial) infection that resulted from surgery in the last 277 cases in the office-based surgical suite. It is categorized by antibiotic used and, in the sole infection case, explains the procedure and follow-up care. This summary is significant in that the only infection in our project analysis was in a high-risk case. In addition, the infection resolved with proper postoperative care.
*Original postoperative doxycycline was discontinued after cultures showed *Serratia marcescens*.

0.681) This indicates that there is no difference between our administration times or our infection rate and those of the hospital's at the 0.05 significance level.

Statistically significant differences were found when comparing our infection rate (0.36%) with the national infection rate of 1.9% [P = 0.030, standard error (SE) = 0.008) and the national plastic surgery infection rate of 3.675% (P = 0.0017, SE = 0.011). At the 0.05 significance level, our infection rates for breast augmentation, breast reduction, abdominoplasty, and rhinoplasty were compared with those discussed by Hsu et al.[26] The clinical suite infection rate for mammoplasty reduction was found to be significantly less than the 8.5% discussed by Hsu et al (P = 0.025, SE = 0.043). Breast augmentation rates could not be compared mathematically because the infection rates were both 0. Abdominoplasty (P = 0.0654, SE = 0.049) and rhinoplasty (P = 0.141, SE = 0.052) did not result in significance because of the large SEs based on sample size.

DISCUSSION

Although extensive Centers for Disease Control and Prevention and Association of Perioperative Registered Nurses recommendations for aseptic technique are implemented in our office-based surgical center, our project focused on the compliance of prophylaxis in the facility. Antibiotic dosing guidelines can be met through repetitive teaching of protocol but may be difficult to achieve in a complex environment such as a teaching hospital. Factors such as staff/shift changes, differing teaching methods, and high volume can inhibit proper protocol. This project is comparative because surgeon, anesthesiologist, physician assistant, nurses, resident, and patient populations were at both facilities.

This failure to comply in hospitals is reflected in the historical National Surgical Infection Prevention Project audit—with only 55.7% of patients receiving prophylaxis within an hour.[24] Nemeth et al[31] examined whether including a prophylaxis reminder in the time-out would improve timeliness compliance. This seems to have indeed worked with compliance increasing to 98%. The University of Washington implemented a software system giving real-time antibiotic reminders to anesthesiologists, increasing timely compliance by 9.3%, and maintaining a >99% compliance rate long term.[32]

A study at an Italian teaching hospital found a reduction in SSI rates over 6 years by implementing appropriate antibiotic administration.[33] However, a noted flaw in the study was inconsistency in objective data recording. This is a real risk if there are no protocol reminders or checklists.

Our project analysis showed 96% compliance with prophylaxis guidelines. The other 4% is more informative in identifying areas of improvement, in that 4 patients lacked documentation of prophylaxis in their operative reports. We interpret this as either complete lack of prophylaxis administration by the anesthesiologist or, more likely, a failure to record the time by the circulator. Seven patients in our analysis also received antibiotics after incision time. A check is now included in the time-out.

Although we can show compliance of prophylaxis is possible, if not better, in an outpatient facility than a hospital, we cannot definitively state that prophylaxis decreases SSI incidence. Besides proper draping[30] and the extensive no-touch technique and Keller funnels used with implant surgery,[34,35] our low infection rate could also possibly be attributable to low sample size. The 0.24% SSI rate at the local hospital is incredibly low compared with the 1.9% national average, setting a high bar to which we compare our infection rates.

Anigian et al[9] show that difference in timing of prophylaxis did not affect their complication rate, and they debate the effectiveness for prophylaxis in clean cases. Hsu et al analyzed the studies looking at breast and other elective surgery—despite the use of implants and nipple contamination risk, there was a minimal difference in SSI in breast augmentations when antibiotic prophylaxis was used (0%–0.7%); however, in clean-contaminated cases such as rhinoplasty, there was a significant difference between prophylactic and nonprophylactic group (0%–8.9%).[26] A study by Landes et al[36] showed that despite widespread use of prophylaxis by plastic surgeons, SSI rates were still present and considered significant—9.3% of 335 procedures.

Our facility continues using the Centers for Disease Control and Prevention-recommended options and doses for antibiotic prophylaxis.[1] Through records and codes, Centers for Medicare and Medicaid Services quality indicators show that smaller office-based suites and ambulatory surgical centers perform better than hospitals[9,10]; yet do not provide adequate information or basis to compare elective aesthetic surgery infection rates. Even national databases that include cosmetic surgery data, such as the National Surgical Quality Improvement Program or Tracking Operations and Outcomes for Plastic Surgeons, are still difficult to analyze because certain variables are unsearchable, are unspecific input narrows specificity by procedure, and can include subjective details during input.[14,15] The average dose to incision time was 15 minutes. This is less than hospitals, which normally do 30 minutes to 1 hour. It is a reflection of operating room efficiency and may require modification if data become available that identify more ideal timing. Modification may include administration of prophylaxis in holding, rather than intraoperatively. Patient care is shifting from inpatient hospital settings to ambulatory outpatient settings, and accreditation services require evidence of adherence to safety guidelines. Patients in general are concerned with infection rates; studies such as these allow patients to make educated choices.

CONCLUSION

The average antibiotic administration to cut time was 15.095 minutes, closer to incision time than some comparisons and within the recommended range of 1 hour. Perioperative administration times of a single-dose antibiotic were recorded in 96% of the cases examined, although no infections resulted from the 4% of cases in which perioperative antibiotic times were not recorded or within an hour of incision. This suggests that a controllable comparison of prophylaxis compliance was statistically better than national rates. It also suggests that our facility's compliance is higher, yet statistically equal to a local hospital, with the same team environment, when protocols are in place, and that a culture of safety is possible in an office-based surgical suite. Of the 277 surgeries analyzed, the SSI rate was 0.36%. This is significantly less than the national average SSI rate of 1.9% and the national plastic surgery rate of 3.675%, but not different than the local hospital's plastic surgery rate of 0.24%. This shows that an accredited office-based suite following appropriate guidelines can meet or exceed expectations for patient safety.

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REFERENCES

1. Mangram, AJ, Horan TC, Pearson, MD, et al. *Guideline for Prevention of Surgical Site Infection.* Atlanta, GA: Centers for Disease Control and Prevention. 1999: 247–278.
2. Calise F, Capussotti L, Caterino S, et al. Perioperative antibiotic prophylaxis in adults. Outline of the principal recommendations. National reference guidelines. *Minerva Anestesiol.* 2009;75:543–547, 548–552.
3. Edminston CE Jr, Spencer M, Lewis B, et al. Reducing the risk of surgical site infections: did we really think SCIP was going to lead us to the promised land? *Surg Infect (Larchmt).* 2011;12:169–177.
4. Liau KH, Aung KT, Chua N, et al. Outcome of a strategy to reduce surgical site infection in a tertiary-care hospital. *Surg Infect (Larchmt).* 2010;11:151–159.
5. Bratzler DW, Houck PM; Surgical Infection Prevention Guidelines Writers Workgroup; American Academy of Orthopaedic Surgeons; American Association of Critical Care Nurses; American Association of Nurse Anesthetists; American College of Surgeons; American College of Osteopathic Surgeons; American Geriatrics Society; American Society of Anesthesiologists; American Society of Colon and Rectal Surgeons; American Society of Health-System Pharmacists; American Society of PeriAnesthesia Nurses; Ascension Health; Association of periOperative Registered Nurses; Association for Professionals in Infection Control and Epidemiology; Infectious Diseases Society of America; Medical Letter; Premier; Society for Healthcare Epidemiology of America; Society of Thoracic Surgeons; Surgical Infection Society. Antimicrobial prophylaxis for surgery: an advisory statement from the National Surgical Infection Prevention Project. *Clin Infect Dis.* 2004;38:1706–1715.
6. Conley DM, Singer SJ, Edmondson L, et al. Effective surgical safety checklist implementation. *J Am Coll Surg.* 2011;212:873–879.
7. Hranjec T, Swenson BR, Sawyer RG. Surgical site infection prevention: how we do it. *Surg Infect (Larchmt).* 2010;11:289–294.
8. Dellinger EP. Prophylactic antibiotics: administration and timing before operation are more important than administration after operation. *Clin Infect Dis.* 2007;44:928–930.
9. Anigian KT, Miller T, Constantine RS, et al. Effectiveness of prophylactic antibiotics in outpatient plastic surgery. *Aesthet Surg J.* 2014;34:1252–1258.
10. *Physician Quality Reporting System.* Baltimore, MD: Centers for Medicare and Medicaid Services. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/PQRS/. Accessed March 24, 2014.
11. Owens PL, Barrett ML, Raetzman S, et al. Surgical site infections following ambulatory surgery procedures. *JAMA.* 2014;311:709–716.
12. Hall BL, Hamilton BH, Richards K, et al. Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program: an evaluation of all participating hospitals. *Ann Surg.* 2009;250:363–376.
13. Alderman AK, Collins ED, Streu R, et al. Benchmarking outcomes in plastic surgery: national complication rates for abdominoplasty and breast augmentation. *Plast Reconstr Surg.* 2009;124:2127–2133.
14. Hanwright PJ, Hirsch EM, Seth AK, et al. A multi-institutional perspective of complication rates for elective nonreconstructive breast surgery: an analysis of NSQIP data from 2006 to 2010. *Aesthet Surg J.* 2013;33:378–386.
15. Mioton LM, Alghoul MS, Kim JY. A comparative analysis of readmission rates after outpatient cosmetic surgery. *Aesthet Surg J.* 2014;34:317–323.
16. Bratzler DW, Hunt DR. The surgical infection prevention and surgical care improvement projects: national initiatives to improve outcomes for patients having surgery. *Clin Infect Dis.* 2006;43:322–330.
17. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health-Syst Pharm.* 2013;70:195–283.

18. Smith B. Infection prevention in ambulatory surgery. *OR Nurse J.* 2013:11–13.
19. Auerbach AD. Prevention of Surgical site infections. Available at: http://archive.ahrq.gov/clinic/ptsafety/chap20a.htm. Accessed April 2016.
20. Haines K, RN, CNOR. Surgical site infections (ssi) following orthopedic surgery. *OR Connection* 2012;7:29–38.
21. Bagdasarian N, Schmader KE, Kaye KS. The epidemiology and clinical impact of surgical site infections in the older adult. *Burr Transl Geriatr Exp Gerontol Rep.* 2013;2:159–166.
22. Kusachi S, Kashimura N, Konishi T, et al. Length of stay and cost for surgical site infection after abdominal and cardiac surgery in Japanese hospitals: multi-center surveillance. *Surg Infect (Larchmt).* 2012;13:257–265.
23. de Lissovoy G, Fraeman K, Hutchins V, et al. Surgical site infection: incidence and impact on hospital utilization and treatment costs. *Am J Infect Control.* 2009;37:387–397.
24. Bratzler DW, Houck PM, Richards C, et al. Use of antimicrobial prophylaxis for major surgery: baseline results from the National Surgical Infection Prevention Project. *Arch Surg.* 2005;140:174–182.
25. *Surgical Care Improvement Project.* The Joint Commission. Available at: http://www.jointcommission.org/surgical_care_improvement_project/. Accessed February 2014.
26. Hsu P, Bullocks J, Matthews M. Infection prophylaxis update. *Semin Plast Surg.* 2006;204:241–248.
27. Moore D, McCabe G, Craig B. *Introduction to the Practice of Statistics.* 7th ed. New York, NY: WH. Freeman; 2012.
28. Sibley Infectious Disease Department. *Sibley Memorial Hospital Infection Control Committee Data.* 2012. Washington, DC.
29. Sibley Infectious Disease Department. *Sibley Memorial Hospital Surgical Site Infections Report.* 2013. Washington, DC.
30. *Periooperative Standards and Recommended Practices.* Denver, CO: AORN, Inc; 2014.
31. Nemeth TA, Beilman GJ, Hamlin CL, et al. Preoperative verification of timely antimicrobial prophylaxis does not improve compliance with guidelines. *Surg Infect (Larchmt).* 2010;11:387–391.
32. Nair BG, Newman SF, Peterson GN, et al. Feedback mechanisms including real-time electronic alerts to achieve near 100% timely prophylactic antibiotic administration in surgical cases. *Anesth Analg.* 2010;111:1293–1300.
33. Prospero E, Barbadoro P, Marigliano A, et al. Perioperative antibiotic prophylaxis: improved compliance and impact on infection rates. *Epidemiol Infect.* 2011;139:1326–1331.
34. Michael SG, Bell MD, Danial McKee. An illuminating nou-touch device for breast augmentation. *Can J Plast Surg.* 2009;17:30–31.
35. Moyer HR, Ghazi B, Saunders N, Losken A. Contamination in smooth gel breast implant placement: testing a funnel versus digital insertion technique in a cadaver model. *Aesthet Surg J.* 2012;32:194–199.
36. Landes G, Harris PG, Lemaine V, et al. Prevention of surgical site infection and appropriateness of antibiotic prescribing habits in plastic surgery. *J Plast Reconstr Aesthet Surg.* 2008;61:1347–1356.