

# The More the Merrier? Should Antibiotics be Used for Rhinoplasty and Septorhinoplasty?—A Review

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**Background:** With antimicrobial resistance a global threat, optimizing antibiotic usage across the surgical continuum is vital. The American Academy of Otolaryngology—Head and Neck Surgery Foundation recently published the first guidelines addressing management in rhinoplasty. The authors reviewed pertinent literature on the role of systemic antibiotics in rhinoplasty and septorhinoplasty.

**Methods:** The authors performed a MEDLINE search through PubMed using the key terms rhinoplasty, septorhinoplasty, infection, antimicrobials, and antibiotics.

**Results:** Ten studies met criteria. Studies evaluating antibiotics perioperatively showed similar infection and/or bacteremia rates (0–13.3%) in those receiving or not receiving antibiotics. No patients experienced significant local/systemic infections regardless of antibiotic use. In the 3 studies evaluating antibiotics postoperatively, antibiotics decreased the infection rate from 27% to 8% in complex revision cases. In a study evaluating postoperative antibiotics in noncomplex cases, there were no significant differences in infection rates between those receiving only a preoperative dose and those receiving preoperative in addition to 7 days of postoperative antibiotics, with the latter experiencing higher rates of antibiotic-related adverse events and costs.

**Conclusions:** Peri- and postoperative antibiotics in noncomplex rhinoplasty and septorhinoplasty are not beneficial in decreasing infection risk. Antibiotics, with a first-generation cephalosporin such as cefazolin (non- $\beta$ -lactam, such as clindamycin, if  $\beta$ -lactam allergy), should be considered in patients with comorbidities/undergoing complex surgery. If perioperative antibiotics are used, antibiotics should be administered within 1 hour of incision and discontinued within 24 hours of the operation. Further research is warranted to evaluate the optimal duration of postoperative antibiotics in complex cases. (*Plast Reconstr Surg Glob Open* 2018;6:e1972; doi: 10.1097/GOX.0000000000001972; Published online 16 October 2018.)

## INTRODUCTION

Rhinoplasty, the third most commonly performed cosmetic operation in the United States, is done for both functional and aesthetic purposes.<sup>1</sup> Antibiotic use peri- and postoperatively in otorhinolaryngological surgeries has been questioned for decades.<sup>2–5</sup> Noting surgi-

cal differences between septoplasty and rhinoplasty when evaluating the role of antibiotics is, first, important. In septoplasty, an incision is made in the nasal mucosa and a portion of the septal cartilage is removed. This is a clean-contaminated procedure as the nasal flora is introduced to the sterile submucosal environment. The nasal skin is not manipulated in septoplasty and natural barriers remain between the contaminated nasal mucosa and the clean skin. In rhinoplasty, whether a skin incision is made or not, there is always an intranasal incision, which leads to contamination of the skin-soft tissue envelope.

Although considered a “nonsterile operation,” literature has supported a lack of clinical need of antibiotics, with infections occurring in < 1% of all septorhinoplasties and rhinoplasties.<sup>5–7</sup> Nonetheless, a survey of rhinoplasty surgeons noted that of the ~220,000 rhinoplasties

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performed each year in the United States, 91% routinely used antibiotics, with ~34% using antibiotics frequently for prophylaxis, 37% deciding on prophylaxis on a case-by-case basis, and 20% using antibiotics for long or contaminated cases.<sup>8</sup>

Albeit the risk of infection is very small, a surgeon's fear over the impact of 1 postoperative infection case prompts this widespread, and often prolonged, administration of antibiotics.<sup>9</sup> Antibiotic use, however, is not devoid of complications. Currently, 700,000 deaths annually are attributed to antimicrobial resistant (AMR) infections, primarily driven by antibiotic overuse. Due to AMR, there is a specific concern over a possible relationship between nasal surgical-site infections (SSIs) and methicillin-resistant *Staphylococcus aureus*.<sup>9–11</sup> Antibiotics can have additional negative implications including gastrointestinal sequelae, *Clostridium difficile* infection and allergic reactions.

The World Health Organization (WHO) recently released the first evidence-based guidelines for SSIs, recommending antibiotic use pre- and intraoperatively, but not postoperatively.<sup>12,13</sup> The Centers for Disease Control and Prevention (CDC) has inconclusive guidance on the role of antibiotics preoperatively, stating their role may be beneficial for certain procedures. For clean and clean-contaminated procedures, the CDC recommends against additional prophylactic antibiotics after closing the surgical incision. Similar to the WHO, the CDC recommends against postoperative antibiotics.<sup>14</sup> The American Academy of Otolaryngology—Head and Neck Surgery Foundation recently published the first guidelines addressing management in rhinoplasty, recommending a single preoperative dose of antibiotic and ≤ 24 hours of postoperative antibiotics and no intranasal packing.<sup>15</sup> Optimizing antibiotic usage across the surgical continuum is key to tackling important drivers of AMR while simultaneously decreasing the burden of infection at the global level.

An extensive literature review evaluating the basis of these guidelines has not been performed. Here, we review the pertinent literature on the role of systemic antibiotics in rhinoplasty and septorhinoplasty and provide our recommendations on which cohort of patients should potentially receive antibiotics peri- and postoperatively (Tables 1, 2).

## MATERIALS AND METHODS

We performed a MEDLINE search through PubMed using the key terms rhinoplasty, septorhinoplasty, infection, antimicrobials, and antibiotics. An additional search was performed in the reference lists of the qualifying articles to identify relevant studies overlooked by the search. Only English and human publications that were randomized control trials, quasi-randomized control trials, controlled clinical trials, retrospective studies, and case series were included. Studies assessing the effectiveness of peri- and postoperative systemic antibiotics, incidence of infection, and bacteremia during rhinoplasty or septorhinoplasty were reviewed. Publications were excluded if they did not meet the aforementioned criteria.

## ROLE OF PERIOPERATIVE ANTIBIOTICS

Prophylactic antibiotics have been recommended by both the WHO and American Academy of Otolaryngology—Head and Neck Surgery Foundation.<sup>13,15</sup> The potential for complications, including postoperative infections and toxic shock syndrome (TSS), following rhinoplasty motivates surgeons to administer prophylactic antibiotics.<sup>6,16,17</sup> Data support the abstinence of antibiotic use in patients undergoing septal surgery; however, conflicting evidence exists for the rhinoplasty population.<sup>18–20</sup>

Several studies have evaluated the incidence of bacteremia in patients undergoing rhinoplasty and septorhinoplasty. Slavin et al.<sup>7</sup> examined 52 rhinoplasty patients who did not receive any antibiotics for ≥ 2 weeks presurgery. Preoperative nasal cultures were obtained as were blood cultures drawn immediately preoperatively and 5 and 15 minutes after completion of osteotomies. Patients were followed for 60 days, none of whom developed local or systemic infections. Of the 312 blood cultures, all intraoperative blood cultures were negative and only 1 postoperative culture grew—*Staphylococcus epidermidis*—attributed to contamination. Another study examined the pre-, intra-, and postoperative blood cultures of 30 septoplasty and 30 open septorhinoplasty patients who received no antibiotics at least 20 days before surgery.<sup>21</sup> All pre- and postoperative blood cultures were negative. One patient undergoing septoplasty (3.3%) had a positive intraoperative blood culture, whereas 13.3% of patients undergoing open septorhinoplasty had positive cultures. No patients expressed clinical signs and symptoms of infection. However, as bacteremia can lead to endocarditis in at-risk patients, such as those with valvular prostheses, cardiac transplants, or histories of endocarditis, this risk should be taken into consideration and relevant preoperative precautions should be implemented in this population.

Cabouli et al.<sup>22</sup> conducted a retrospective review of 2,000 cases of aesthetic rhinoplasty where no patients received antibiotics. They reported an infection rate in 0.6% (12/2000) of patients; however, only 5 patients had adequate documentation for review. They postulated that infection risk was more closely related to technical aspects of the operation (external osteotomies, revision surgery) rather than the presence of bacteria; however, there is no strong evidence to support this. Baran et al.<sup>23</sup> classified 1,400 patients into 4 groups, including 1 group of 300 patients who underwent a cosmetic surgical procedure (rhinoplasty, blepharoplasty, rhytidectomy, abdominoplasty, liposuction, or reduction mammoplasty). Complex cases were excluded from this study. These patients were randomized to receive a single intravenous (IV) dose of ampicillin-sulbactam or placebo. There was no statistically significant difference in infection rate between the group receiving antibiotics and those receiving placebo.<sup>23</sup>

Yoo et al.<sup>10</sup> evaluated the role of preoperative antibiotic prophylaxis in a retrospective review of 363 patients who underwent preoperative nasal swab testing (4–14 days before surgery) and rhinoplasty or septorhinoplasty. Only those with potentially pathogenic bacteria were administered culture-directed antibiotics, with trimethoprim-

**Table 1. Studies Evaluating Role of Peri- and Postoperative Antibiotics in Septorhinoplasty and Rhinoplasty**

Author	Sample Size	Study Design and Population	Antibiotic Course	Outcome Measure	Key Findings
Perioperative antibiotics Slavin et al. <sup>7</sup>	52 patients	Prospective observational study; rhinoplasty	Patients did not receive antibiotics > 2 weeks presurgery	Incidence of bacteremia	<ul style="list-style-type: none"> <li>No local or systemic infections in any patients throughout a 60-day postoperative period</li> <li>Of the 312 blood cultures, all intraoperative blood cultures were negative and only 1 postoperative culture grew, attributed to contamination.</li> </ul>
Okur et al. <sup>21</sup>	60 patients (30 SP; 30 open SRP)	Prospective observational study; SP and open SRP	Patients did not receive antibiotics > 20 days presurgery	Incidence of bacteremia	<ul style="list-style-type: none"> <li>No local or systemic infections in any patients</li> <li>No blood cultures taken preoperatively or postoperatively were positive for any organisms.</li> <li>SP: 1/30 patients (3.3%) had bacterial growth intraoperatively</li> <li>Open SRP: 4/30 patients (13.3%) had bacterial growth intraoperatively</li> </ul>
Andrews et al. <sup>24</sup>	164 patients (82 prophylactic arm; 82 postoperative arm)	Randomized, prospective, single-blinded trial; SRP	3–1,200-mg IV doses of amoxicillin-clavulanate, given at induction of anesthesia and at 6 and 12 hours postoperatively	Evidence of infection on 10th postoperative day	<ul style="list-style-type: none"> <li>6/82 patients (7%) in the prophylactic arm showed evidence of infection, with most infections minor, defined as vestibular cellulites</li> <li>Out of the 6 patients who developed infections, 2 had septal perforation repair; 2 had external SRP; and 2 had internal SRP</li> <li>RR of infection for those treated with prophylaxis was 0.67 (95% CI, 0.25–1.79).</li> </ul>
Cabouli et al. <sup>22</sup>	2,000 patients	Retrospective study; aesthetic primary or secondary rhinoplasty	No antibiotics preoperatively	Incidence of infection	<ul style="list-style-type: none"> <li>12/2,000 patients (0.6%) developed an infection; however, only 5 patients had adequate documentation for review</li> </ul>
Toia et al. <sup>25</sup>	1,110 patients total (287 patients with clean procedures and rhinoplasty)	Prospective observational study; elective clean or clean-contaminated surgical procedures	Patients with ASA scores $\geq 3$ or patients whose surgery lasted > 3 hours received antibiotic prophylaxis, with a single dose of IV cefazolin administered 30–60 min before incision	Incidence of infection	<ul style="list-style-type: none"> <li>34.1% patients received antibiotic prophylaxis</li> <li>3/287 patients (1%) developed an infection</li> <li>Cigarette smoking and length of procedure risk factors for infection.</li> </ul>
Yoder and Weimert <sup>6</sup>	1,040 patients	Prospective observational study; SP and SRP	No patients received prophylactic antibiotics	Incidence of infection	<ul style="list-style-type: none"> <li>5/1,040 patients (0.48%) developed minor nasal infections, which resolved after a short course of oral antibiotics</li> </ul>
Weimert and Yoder <sup>28</sup>	174 patients (106 septal surgery; 68 rhinoplasty)	Randomized, prospective study; septal surgery and rhinoplasty	One group received ampicillin, 500 mg every 12 hours preoperatively and for 5 days after the procedure, and the other group did not take any antibiotics	Effectiveness of antibiotics	<ul style="list-style-type: none"> <li>The 5 patients who developed an infection did not require hospitalization or IV antibiotics.</li> <li>No patients demonstrated clinical or radiographic evidence of sinusitis</li> <li>No significant abnormalities between the groups were noted in terms of infection, scabs, bleeding, synechia, pain, or ecchymoses.</li> <li>4 patients (2.3%; 2 patients in each group) had minor postoperative infections, which resolved quickly when antibiotics were administered.</li> </ul>

(Continued)

**Table 1. Continued**

Author	Sample Size	Study Design and Population	Antibiotic Course	Outcome Measure	Key Findings
Yoo et al. <sup>10</sup>	363 patients	Retrospective study; rhinoplasty or SRP	All patients underwent preoperative nasal swab testing (4–14 days before surgery). All patients used chlorhexidine gluconate and mupirocin ointment intranasally twice daily for 5 days before surgery. All patients received 1 gram of IV cefazolin, or 450 mg clindamycin if penicillin allergy, 30 minutes before the first incision. When non-normal flora was detected via nasal swab cultures, patients were treated with culture-directed preoperative oral antibiotics, with trimethoprim-sulfamethoxazole being most commonly used	Incidence of infection	<ul style="list-style-type: none"> <li>11/363 patients (3%) developed postoperative infection—4% primary SRP; 2.1% revision cases</li> <li>Of these 11 patients, 2 were taking oral contraceptive drugs, 2 had acne, 2 were smokers, 1 had gastroesophageal reflux disease and 1 tested positive for human immunodeficiency virus.</li> <li>Of these 11 postoperative cultures, <i>S. aureus</i> was the most common organism isolated (4 patients)</li> </ul>
Postoperative antibiotics Pirsig and Schafer <sup>33</sup>	100 patients	Randomized, prospective study; complex rhinoplasty	48 patients received 3 mega units of oral propicillin starting 6 hours postoperatively for 12 days; 52 patients received placebo	Efficacy of antibiotics	<ul style="list-style-type: none"> <li>Placebo: 14/52 patients (27%) acquired infection</li> <li>Antibiotics: 4/48 patients (8%) acquired infection</li> </ul>
Andrews et al. <sup>24</sup>	164 patients (82 prophylactic arm; 82 postoperative arm)	Randomized, prospective, single-blinded trial; SRP	375 mg of oral amoxicillin-clavulanate three times a day for 7 days, starting after surgery	Evidence of infection on 10th postoperative day	<ul style="list-style-type: none"> <li>9/82 patients (11%) in the postoperative arm showed evidence of infection, with most infections minor, defined as vestibular cellulites</li> <li>Out of the 9 patients that developed infections, 3 had septal perforation repair; 3 had external SRP; and 3 had internal SRP</li> </ul>
Rajan et al. <sup>34</sup>	200 patients	Prospective, randomized, single-blind study; SRP	Single dose preoperative IV amoxicillin-clavulanate 2.2 g 30 minutes before incision versus a combined regimen with preoperative IV amoxicillin-clavulanate 2.2 g 30 minutes before incision + postoperative 7-days amoxicillin-clavulanate 1,000 mg 2 times daily	Wound infection 30 days postoperatively	<ul style="list-style-type: none"> <li>3/100 patients (3%) in combined treatment group developed postoperative local wound infections; no infections occurred in the group treated with the preoperative single IV dose at induction alone.</li> <li>29% in the combined treatment group versus 2% in the group receiving a single preoperative dose experienced antibiotic-related side effects (<math>P = 0.03</math>; e.g., nausea, diarrhea, skin rashes, pruritus).</li> <li>The cost for antibiotics and medication to treat the side effects per patient was significantly higher in the combined treatment group (93.45 AUD versus 14.50 AUD; <math>P=0.04</math>)</li> </ul>

ASA, American Society of Anesthesiologists; CI, confidence interval; IV, intravenous; RR, relative risk; SP, septoplasty; SRP, septorhinoplasty.



**Table 2. Summary of Recommendations for Systemic Antibiotics in Septoplasty, Septorhinoplasty, and Rhinoplasty**

Procedure	Preoperative Antibiotics	Perioperative Antibiotics	Postoperative Antibiotics
Septoplasty	No	No	No
Primary SRP/primary rhinoplasty	No	No	No
Revision/complex SRP or rhinoplasty	No	Yes, within 60 minutes of incision	Consider*†

\*Inadequate data to recommend duration.

†Consider in: cardiac patients at risk for endocarditis, surgical procedures lasting > 3 hours in patients with comorbidities, current smoking, revision surgeries, septal reconstruction, osteotomies, wedge resection, and free transplants. SRP, septorhinoplasty.

sulfamethoxazole being most common. All received a prophylactic dose of IV cefazolin 1 g, 30 minutes before the first incision. One hundred seventy-four and 189 patients underwent primary and revision rhinoplasty, respectively. There was no significant difference in preoperative culture results in patients undergoing primary rhinoplasty compared with those undergoing revision rhinoplasty. The overall postoperative infection rate was 3% (11 patients). Postoperative infections were more common in primary septorhinoplasties (4%) than in revision cases (2.1%;  $P > 0.05$ ). Except in 1 case, the bacteria cultured from a postoperative infection did not correlate with the preoperative culture result. This study did not include the duration of preoperative antibiotics administered in those patients who had nonnormal flora isolated from their nasal swabs, and no information on antibiotic therapy postoperatively was provided.

Albeit the study by Yoo et al.<sup>10</sup> included 189 patients undergoing revision rhinoplasty, limited data exist on the role of antibiotics in revision cases. Andrews et al.<sup>24</sup> evaluated the efficacy of only prophylaxis compared with only postoperative antibiotic use in complex septorhinoplasty. Complex was defined as patients who required grafting and/or revision cases. Patients randomized to the prophylactic arm received three 1,200-mg IV doses of amoxicillin-clavulanate, given at induction of anesthesia and at 6 and 12 hours postoperatively. Those receiving postoperative antibiotics received 375 mg of oral amoxicillin-clavulanate 3 times a day for 7 days, starting after surgery. There were no intraoperative or postoperative cultures drawn, with only preoperative cultures obtained. At follow-up, on the 10th postoperative day, each patient was evaluated for evidence of infection as the primary outcome measurement. From 164 patients, 89% had a revision and/or graft and 11% had septal perforation repair. The overall infection rate was 9% (15/164). The infection rate was similar in the prophylactic compared with postoperative arm (7% versus 11%;  $P = 0.42$ ), with most infections minor, defined as vestibular cellulitis. *Staphylococcus aureus* was the most common pathogen isolated. As few studies have evaluated the role of antibiotics in complex procedures, an attribute of this study is that the investigators only included complex cases, excluding those requiring routine primary nasal surgery. From the 15 patients incurring an infection, 10 patients had more complex nasal procedures, such as septal perforation repair and revision external surgery, where, due to the length of surgery and greater tissue exposure, a higher contaminant exposure was encountered.

Toia et al.<sup>25</sup> evaluated the role of prophylactic antibiotics in patients undergoing an elective clean or clean-contaminated surgical procedure. Procedures were divided into 4 groups, with group 2, the group of interest for this review, comprising 287 patients with clean surgery (head and neck, breast, limbs, lymphadenectomy and lymph node dissections, peripheral nerves, cosmetic procedures) and rhinoplasty.<sup>25</sup> The prophylaxis protocol followed the Italian National guidelines and prophylactic antibiotics were administered according to patient-related and procedure-related risk factors.<sup>26</sup> From these 287 patients, 98 (34.1%) were complex—defined as having American Society of Anesthesiologists (ASA) scores of  $\geq 3$  [ASA class 3 is defined as a patient with severe systemic disease with substantive functional limitations. Examples include poorly controlled diabetes mellitus, hypertension, chronic obstructive pulmonary disease, morbid obesity (BMI  $\geq 40$ ), active hepatitis, alcohol dependence, or abuse, etc.] or those whose surgery lasted > 3 hours. These complex patients received perioperative antibiotics, including one dose 30–60 minutes prior incision of IV cefazolin 2 g, with a second intraoperative dose given in operations lasting double the half-life of antibiotic administered, if blood loss during surgery exceeded 1,500 ml or if blood dilution exceeded 15 ml/kg. Of the 287 patients, 3 (1%) developed an infection. Cigarette smoking and length of procedure (> 3 hours) were the only statistically significant risk factors for infection. Similar to other studies, this analysis grouped rhinoplasty patients with those undergoing clean procedures, which is a limitation in analyzing the results. However, similar to the studies by Andrews et al.<sup>24</sup> and Yoo et al.<sup>10</sup>, high-risk cases were included.

Various studies have combined septal surgery and open rhinoplasty, skewing the data as these procedures are related but not identical in infection risk.<sup>15,27</sup> Yoder and Weimert<sup>5</sup> conducted a study that included 1,040 patients who underwent septoplasty or septorhinoplasty, with no patients receiving prophylactic antibiotics and no topical surgical preparation used.<sup>5</sup> Five patients (0.48%) developed minor nasal infections that resolved after a short course of oral antibiotics. In another study conducted by Weimert and Yoder,<sup>28</sup> 174 patients undergoing septal surgery ( $n = 106$ ) or rhinoplasty ( $n = 68$ ) were evaluated prospectively to determine the efficacy of systemic antibiotic prophylaxis. One group was treated with ampicillin 500 mg every 12 hours preoperatively and continued for 5 days after the procedure, and the other group did not receive antibiotics. Patients were evaluated through

questionnaires and serial x-rays of paranasal sinuses. No patients demonstrated clinical or radiographic evidence of sinusitis and only 4 patients (2.3%) (2 in each group) experienced minor postoperative infections, which resolved quickly when antibiotics were administered. No significant abnormalities between the groups were noted in terms of infection, scabs, bleeding, synechia, pain, or ecchymoses.

We recommend antibiotics not be used perioperatively in noncomplex cases. As Krizek et al.<sup>29</sup> mentioned, an exceedingly large sample size is needed to show any benefit from the use of prophylactic antibiotics in these procedures, since the SSI rate is so low. In complex cases (ASA scores  $\geq 3$  and/or those whose surgery lasted  $> 3$  hours), we recommend perioperative antibiotics within 1 hour of incision as the studies included in our analyses most commonly used this time frame and as recommended by the surgical prophylaxis guidelines.<sup>30</sup> We recommend a first-generation cephalosporin, such as cefazolin, (non- $\beta$ -lactam, such as clindamycin, if  $\beta$ -lactam allergy) as normal flora and *S. aureus* are responsible for most infections from these procedures.<sup>10</sup>

### ROLE OF POSTOPERATIVE ANTIBIOTICS

The WHO and rhinoplasty guidelines recommend antibiotics not be used for  $> 24$  hours postoperatively, as is often done, due to a low risk of infection.<sup>12,15,31</sup> Grunebaum and Reiter<sup>32</sup> found that 49% of surgeons use antibiotics postoperatively for  $> 24$  hours. Another survey noted that of 440 surgeons using antibiotics, 31% used antibiotics for  $> 4$  days after rhinoplasty.<sup>2</sup> This highlights that antibiotics are being inappropriately overused in rhinoplasty postoperatively. We discuss the existing literature to determine where, if any, benefit exists.

Pirsig and Schafer<sup>33</sup> performed the only prospective study comparing the efficacy of antibiotics with that of placebo in complex nasal surgery in 100 patients (48 patients received 3 mega units of oral propicillin for 12 days; 52 patients received placebo). All cases were revision rhinoplasties and 40% had been operated on more than once prior. In most cases, a complete rhinoplasty with septal reconstruction, osteotomies, wedge resection, and free transplants had to be done. All patients, including those in the placebo arm, were treated with postoperative nasal packing that was impregnated with antibiotics and left in place for 6 days. There was a reduction observed in postoperative infection rates with the use of postoperative antibiotics, with an infection rate of 27% in the placebo arm (14 of 52) and 8% (4 of 48) in the postoperative antibiotic arm. This study did not evaluate the use of antibiotic prophylaxis. This is one of the few studies that evaluated the use of antibiotics in patients that underwent complicated revision rhinoplasties often involving free transplants. As there was an infection rate of 27%, in the placebo arm, postoperative antibiotics would be advantageous in this complex patient population.

Rajan et al.<sup>34</sup> conducted a prospective, randomized, single-blind study, including 200 septorhinoplasty patients over a 4-year period. No patients underwent sinus surgery

in the same procedure or had undergone previous nasal surgery. Patients with significant comorbidities were excluded. One hundred patients received a single dose of preoperative antibiotics, and the other 100 received a combined regimen with preoperative single-shot antibiotics plus a postoperative 7-day course of oral antibiotics. In the group with combined treatment, 3/100 patients (3%) developed postoperative local wound infections; no infections occurred in the group treated with the preoperative single IV dose at induction alone. Significantly more patients in the combined treatment group compared with the group receiving a single preoperative dose (29% versus 2%;  $P = 0.03$ ) experienced antibiotic-related side effects. Additionally, the cost for antibiotics and medication to treat the side effects per patient was significantly higher in the combined treatment group (93.45 Australian Dollar (AUD) versus 14.50 AUD;  $P = 0.04$ ). This study highlights that a single preoperative dose is as effective and associated with significantly less adverse events and cost as systemic antibiotics for 1 week in noncomplex procedures.

We recommend antibiotics not be used postoperatively in noncomplex rhinoplasty and septorhinoplasty cases. In complex cases (ie, complicated revision rhinoplasties, complete rhinoplasties with septal reconstruction, osteotomies, wedge resection, and free transplants), we recommend postoperative antibiotics with a first-generation cephalosporin, such as cefazolin (non- $\beta$ -lactam, such as clindamycin, if  $\beta$ -lactam allergy).<sup>10,33</sup>

### DISCUSSION

Several surveys have shown that a majority of plastic surgeons use antibiotics for facial plastic surgical procedures, although few studies support this.<sup>2,8,32</sup> Albeit postoperative infections are rare after plastic surgery, plastic surgeons most commonly overprescribe antibiotics as cosmetic infections can seriously affect the aesthetic outcome, which may not be as big of a concern in noncosmetic operations. Given that overusing antibiotics in rhinoplasty and septorhinoplasty cases is more the norm, a behavior change must occur in surgeons to be a part of the solution in decreasing AMR.

Many use antibiotics to prevent TSS in patients with nasal packing who have undergone nasal surgery. Intranasal packing includes ribbon gauze, expandable pads, and nonstick dressing material and their use is not advocated by the American Academy of Otolaryngology-Head and Neck Surgery Clinical Practice Guidelines unless there is persistent surgical bleeding. The guidelines specify that silastic stents and nasal splints are not considered nasal packing and do not place patients at risk of TSS.<sup>15</sup>

Limitations to this study should be addressed. First, we acknowledge the heterogeneity in studies included, with there being different standardized methods, patient populations, antibiotic regimens, and durations used. Various studies incorporated both septoplasty and rhinoplasty patients, which skews data as the potential for infection between the 2 operations is different.<sup>7,21,27</sup> However, our inclusion criteria were selective to decrease heterogeneity in studies included. Additionally, the introduction of

selection bias and other biases carried over from the studies should be recognized. Lastly, as there were limited studies performed in complex nasal surgery cases in evaluating the use of postoperative antibiotics, there is inadequate information to provide recommendations on the duration of therapy in these cases. Our study highlights the need for further research in this patient population.

When considering antibiotics in rhinoplasty, known risk factors for infection including history of diabetes, obesity, tobacco use, prolonged surgery, and compromised vascular supply to the nasal skin as a result of prior operations or trauma should be considered. The only documented factors for increased infection in plastic surgery include operations  $\geq 3$  hours and cigarette smoking. Again, this conclusion was drawn from rhinoplasty patients grouped in with other clean plastic surgery operations.<sup>25</sup> All patients with ASA class  $\geq 3$  were administered prophylactic antibiotics, limiting the analysis of infection in this population.

In conclusion, we recommend against peri- and postoperative systemic antibiotic use in noncomplex rhinoplasty and septorhinoplasty cases. In patients with an increased risk of infection (revision surgery, medical co-morbidities, prolonged operations, use of alloplastic implants, nasal packing) antibiotic use with a first-generation cephalosporin such as cefazolin (non- $\beta$ -lactam, such as clindamycin, if  $\beta$ -lactam allergy) should be considered. Further research in these complex, prolonged cases and in patients with significant comorbidities is needed. If used, perioperative antibiotics should be administered within 1 hour of incision and discontinued within 24 hours of the operation unless a prolonged course is clinically warranted. Of note, primary, noncomplex rhinoplasties may frequently run  $> 3$  hours, even in experienced hands. The complexity of the operation should be considered more important than duration of the procedure when considering the need for antibiotics. Finally, further research is warranted to determine the optimal duration of postoperative antibiotics in complex cases.

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