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Antibiotic prophylaxis for patients undergoing rhinologic surgeries: a survey of Belgian otorhinolaryngologists*

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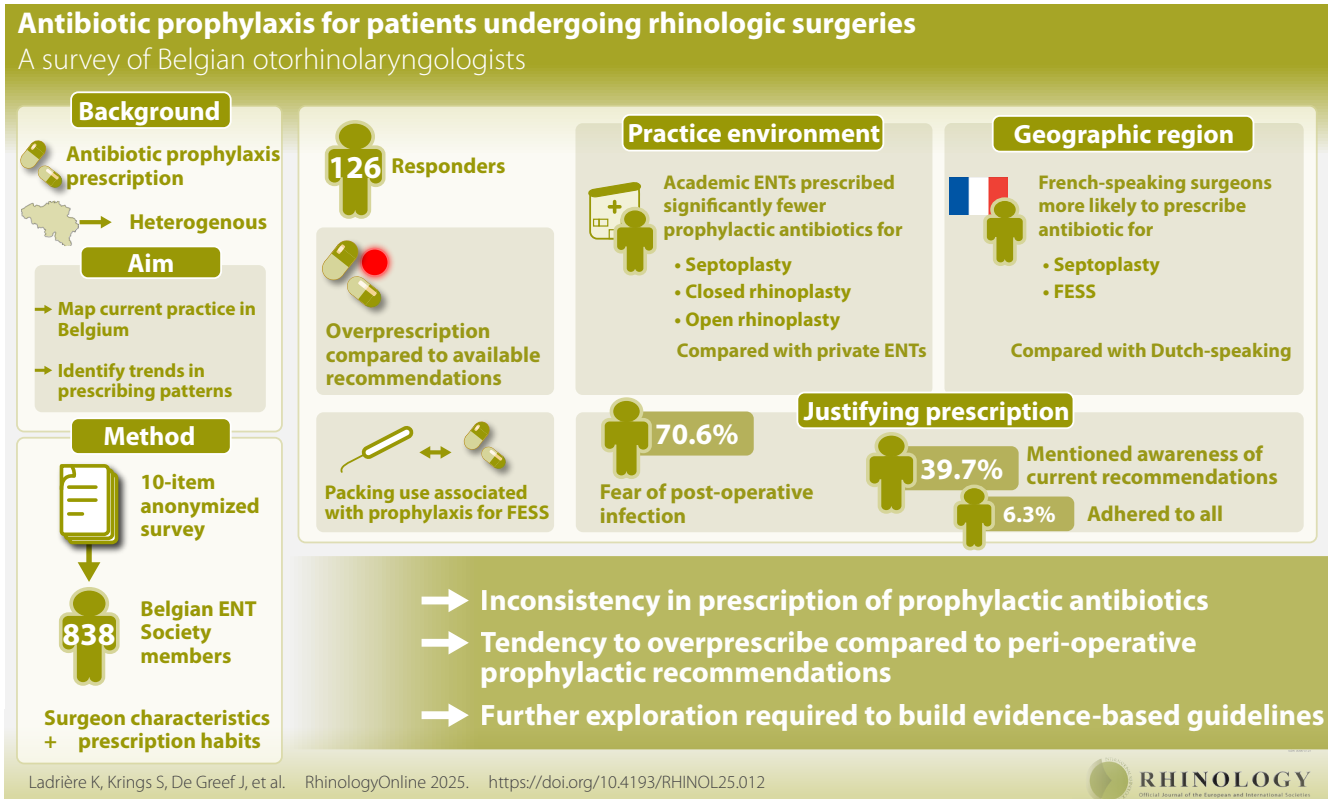

Abstract

Background: As antibiotic prophylaxis prescribing practices in rhinologic surgeries are heterogeneous, given the paucity of evidence, we aimed at mapping the current practice in our country and identify trends in prescribing patterns.

Methods: A 10-item anonymized survey asking about surgeon's characteristics as well as his/her prescription habits was electronically sent out to 838 members of the Belgian ENT Society. Prescribing patterns were analyzed and associations with the different variables were calculated.

Results: Among 126 responders, our analysis revealed a tendency towards overprescription of prophylactic antibiotics compared to the available recommendations. Practice environment was an important determinant for antibiotic prophylaxis prescription

since academic ENTs prescribed significantly fewer prophylactic antibiotics for septoplasty, closed rhinoplasty and open rhinoplasty compared to private practice ENTs. Also, geographic region of practice was a significant determinant with French-speaking surgeons being more likely to prescribe antibiotic for septoplasty and functional endoscopic sinus surgery (FESS) compared to Dutch-speaking surgeons. The use of packing was significantly associated with antibiotic prophylaxis for, but not for septoplasty nor rhinoplasty. 70.6% justified prescription by the fear of post-operative infection. 39.7% of the respondents mentioned being aware of current recommendations, while we found that only 6.3% adhered to all of them.
Conclusion: This study demonstrates the inconsistency of prophylactic antibiotic prescribing among rhinologic surgeons, with a tendency to overprescribing compared to peri-operative prophylactic recommendations. These issues should be explored further to build evidence-based guidelines for optimizing antibiotic prophylaxis.

Key words: antibiotic prophylaxis; septoplasty; FESS; septorhinoplasty; rhinologic surgery

Introduction

Antibiotic resistance has become a major public health and economic concern worldwide. In Europe, an estimated 33,000 patients die each year due to drug-resistant infections and more than half are healthcare-acquired [1]. This alarming tendency is fostered by antibiotic overuse and misuse: inadequate dosing, poor adherence to treatment guidelines, wrong indications including inappropriate prophylactic antibiotic use [2,3].
The most common rhinologic surgeries in the Western world such as septoplasty, functional endoscopic sinus surgery (FESS) and rhinoseptoplasty (RSP) are known to be "clean-contaminated" procedures. Moreover, the use of grafts, such as homo- or allografts, and the presence of foreign bodies such as splints and packing, which are usually left in place, could theoretically increase the risk of infection or toxic shock syndrome (TSS) [4]. Therefore, antibiotic prophylaxis may be considered appropriate with these surgeries. Even more since post-operative infections could pose a significant problem, including the risk of infected septal hematoma with necrosis, post-operative sinusitis and even intracranial infections [4-8].
Unfortunately, there is a lack of available data on the use of prophylactic antibiotics in these surgeries [9,10]. The Surgical Infection Society revealed in their 2013 guidelines that prophylaxis recommendations in the head and neck region were graded with much lower evidence than those for other types of surgeries [9]. In 2018, a systematic review performed by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) was published summarizing the current evidence on prophylactic antibiotic use in ENT surgery [10]. Based on the available – but scarce – literature, it was recommended that no peri-operative antibiotic prophylaxis was needed for septoplasty (grade A), nor for FESS (grade D). This also held true for simple RSP (grade B), while for complex RSP (involving grafting or revision cases) intra-operative antibiotics were recommended, as well as post-operative antibiotics for <24h (grade B). The latter scheme is also recommended for endoscopic anterior skull base surgery (ASBS). Regarding FESS, no antibiotic prophylaxis is recommended (grade D for intra-operative, grade A for post-operative antibiotics). Of note, the authors stated that post-operative antibiotics can be considered when splinting/packing is left in place for over 48h because of a lack of evidence [10]. Apart from this publication, no internationally accepted guidelines have been published on the use of prophylactic antibiotics in rhinologic surgery.
In 2001, a survey of 743 members of the American Rhinologic Society (ARS) published the practice patterns for surgical antibiotic prophylaxis after septoplasty surgery among their members: at that time sixty-six percent of professionals routinely used antibiotics after performing a septoplasty [11]. More recently, in 2018 and 2019, two surveys were sent to ARS members on perioperative antibiotic use patterns after FESS and endoscopic ASBS. Again, most respondents reported prescribing antibiotics and the reasons given varied widely [12,13].
With this study, we aimed at collecting data from Belgian ENT surgeons by means of a nationwide survey and check them against the previously published studies and systematic reviews on this topic. We also set out to assess the current knowledge of Belgian ENT surgeons regarding perioperative antibiotic use as well as their reasons for prescribing them.

Materials and methods

A 10-item online questionnaire on antibiotic prophylaxis in rhinologic surgery was designed using LimeSurvey® and sent to 838 members of the Belgian ENT Society in April 2023. It was emailed twice over two weeks in French and Dutch. The survey was approved by the local ethical committee, and responses were anonymous.
The questionnaire gathered data on the demographic attributes of the participants, including their clinical practice type, geographical localization and years of experience. Participants were then questioned on the frequency of performed rhinologic surgeries (septoplasty, FESS, closed and open RSP and endoscopic ASBS). Their use of intranasal packing and splinting was assessed. Intra- and post-operative antibiotic practice patterns

Table 1. The distribution of the responding ENT surgeons based on their demographic and professional characteristics (N=126).

Variables	n (%)
Age	
<40 years	65 (51.6)
41-50 years	25 (19.8)
51-60 years	19 (15.1)
>60 years	17 (13.5)
Gender	
Male	47 (37.3)
Years of practice (including residency)	
0-5	22 (17.5)
6–10	21 (16.7)
11–15	27 (21.4)
16–20	15 (11.9)
>20	41 (32.5)
Work setting	
Academic hospital	32 (25.4)
Independent or private practice	67 (53.2)
Combination of both	27 (21.4)
Geographic region/Language	
French	52 (41.3)
Dutch	74 (58.7)

were then evaluated, including their antibiotic of preference and the number of dosages administered. Intra-operative use of antibiotics was defined as the administration of antibiotics between 60 minutes prior to surgical incision and the end of surgery, while post-operative use referred to the period following the end of the surgery. The participants were asked about their reasons for prescribing antibiotics as well as about their knowledge on the guidelines of antibiotic prophylaxis (Supplementary Resource 1).

The results were then analyzed for comparison. The frequency and percentage were calculated for each item in the survey and presented in tables. Chi-square analysis with a Fisher exact test was employed to analyze the link of prescription behavior with each variable. For our analysis, we grouped certain subcategories together to ensure the validation of the hypothesis underlying the test. Post-operative antibiotic use was reduced to a binary variable by addressing those who prescribe antibiotics in more than 70% of the cases as "prescribers" and those who prescribe antibiotics in less than 70% of the cases as "non-prescribers". Also, for the packing variable, we combined the two packing subcategories (resorbable and non-resorbable) together. As such, we aimed to address the potential limitations associated with analyzing the subcategories individually. This approach allowed us to enhance the statistical power of our analysis. The threshold for statistical significance was set at $p<0.05$. The IBM SPSS Statistics v26.0 (IBM Corp, Armonk, NY, USA) was used for the statistical analysis.

Results

Cohort demographics

Of the 838 ENT surgeons that were contacted, 152 started the survey and 126 completed it (response rate of 15.3%). Only complete survey responses were included in the data analysis.

Table 1 depicts the demographic information of the respondents. Responders were well distributed for both age and years of experience. Most participants (53.2%) practiced solely in independent or private practices and 25.4% of participants worked exclusively in academic hospitals with the remaining 21.4% working in both. Respondents were geographically well distributed, mirroring national demographics (58.7% Dutch-speaking vs. 41.3% French-speaking surgeons) (Table 1).

Table 2 depicts the number of rhinologic surgeries performed by the responders, as well as their splinting and packing habits. Most of the surgeons regularly performed septoplasty (98.4%) and FESS (97.6%) while about half the surgeons performed RSP (45.2% closed and 44.4% open/complex). Only 27.8% of respondents performed ASBS. 72.5% of the responders used splinting after septoplasty and 57.2% packed the nose. 64.9% used splinting for closed RSP while 75% used it for open RSP. A bit less than half of the surgeons did not use any packing or splinting after FESS (Table 2).

Prophylactic antibiotic prescription in septoplasty

Among the surgeons who performed septoplasty, a minority (25%) administered an intra-operative antibiotic (Table 3). Of those, most of the surgeons chose 1 g of amoxicillin/clavulanate (25.8%), or first or second generation of cephalosporin (G1-2C) 1 or 2 g (38.8%) (Supplementary Resource 2). After septoplasty, 43.6% of surgeons prescribed antibiotics in most or all cases. 32.2% prescribed less than 70% of the time and 24.2% of participants never prescribed any post-operative antibiotic (Table 3). The most frequently prescribed post-operative antibiotics were amoxicillin/clavulanate at a dosage of 875/125 mg three times a day (3x/d) (36.2%) and 500 mg of G1-2C 3x/d (17%) (Supplementary Resource 2).

Prophylactic antibiotic prescription in FESS

During FESS, 33.3% of the surgeons prescribed intra-operative antibiotics (Table 3). Of those, 22% prescribed 2 g of G1-2C while 17.1% prescribed 1 g of amoxicillin/clavulanate (Supplementary Resource 2). In the post-operative phase of FESS, 39% of responders prescribed antibiotics in most or all cases. Half of the surgeons prescribed them in some cases and 11.4% never (Table

Table 2. Number of annual rhinologic surgeries performed by Belgian ENT respondents and packing/splinting habits.

	Number of surgeries performed annually by the surgeon N=126			Packing/splinting by type of surgery			
	None n (%)	<50 n (%)	>50 n (%)	None n (%)	Packing Res n (%)	Packing Non-Res n (%)	Splints n (%)
Septoplasty	2 (1.6)	97 (77)	27 (21.4)	7 (5.6)	3 (2.4)	68 (54.8)	90 (72.5)
FESS	3 (2.4)	106 (84.2)	17 (13.4)	55 (44.7)	29 (23.5)	48 (39)	9 (7.3)
Closed RSP	69 (54.8)	51 (40.5)	6 (4.7)	6 (10.5)	1 (1.7)	32 (56.1)	37 (64.9)
Open RSP	70 (55.6)	45 (35.7)	11 (8.7)	3 (5.4)	0 (0)	31 (55.3)	42 (75)
ASBS	91 (72.2)	35 (27.8)	0 (0)	7 (20)	15 (42.8)	18 (51.4)	6 (17.1)

FESS: Functional Endoscopic Sinus Surgery; RSP: rhinoseptoplasty; ASBS: endoscopic anterior skull base surgery; Res: resorbable; Non-Res: non-resorbable.

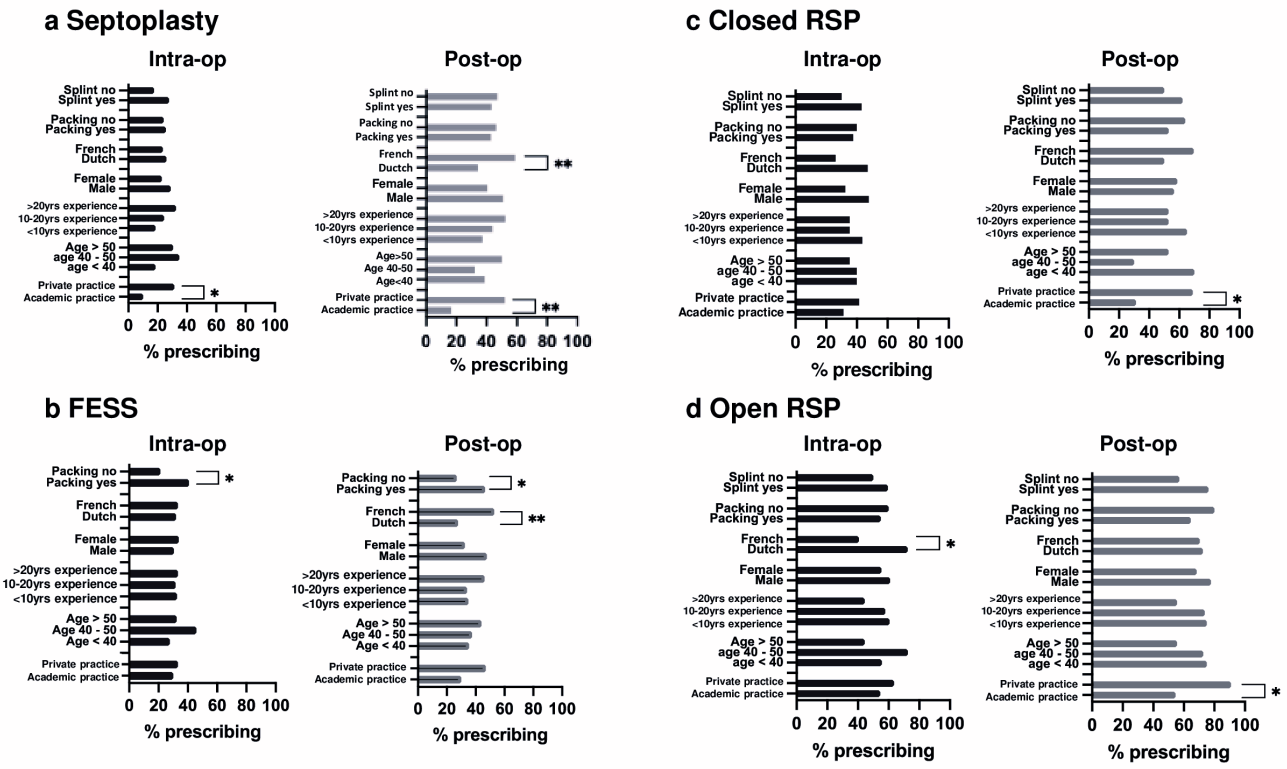

Figure 1. Determinants habits of intra-operative and post-operative prescription of the respondents. Abbreviations – Intra-op: intra-operative; Post-op: post-operative; FESS: Functional Endoscopic Sinus Surgery; RSP: rhinoseptoplasty; Yrs: years. Histograms representing determinants habits of intra-operative and post-operative prescription of the respondents: a in septoplasty; b in FESS; c in closed RSP; d in open RSP. *P-value<0.05; **P-value<0.01.

3). Amoxicillin/clavulanate for 3x/d at 875/125 mg was the main post-operative antibiotic given (39.4%), G1-2C 500 mg for 3x/d followed second in row (12.8%) (Supplementary Resource 2).

Prophylactic antibiotic prescription in rhinoseptoplasty

Among the surgeons performing closed RSP, 38.6% of the participants prescribed intra-operative antibiotics (Table 3). 31.8% of the prescribers used G1-2C at a dosage of 1 g. 22.7% used amoxicillin/clavulanate at a dosage of 1 g (Supplementary Resource 2). Post-operatively, 57.9% of the surgeons performing closed RSP indicated that they prescribed antibiotics in most or all cases and 31.6% prescribed them in some cases. Only 10.5% never prescribed post-operative antibiotics (Table 3). Amoxicillin/clavulanate 875/125 mg 3x/d was the main post-operative

Table 3. Peri-operative antibiotic prescribing habits of Belgian ENT surgeons.

	Septoplasty	FESS	Closed RSP	Open RSP	ASBS
Do you prescribe intra-operative Abx?	**N=124 n (%)**	**N=123 n (%)**	**N=57 n (%)**	**N=56 n (%)**	**N=35 n (%)**
Yes	31 (25)	41 (33.3)	22 (38.6)	32 (57.1)	25 (71.4)
Which intra-operative Abx do you prescribe ?	**N=31 n (%)**	**N=41 n (%)**	**N=22 n (%)**	**N=32 n (%)**	**N=25 n (%)**
First and second generation of cephalosporin	15 (48.4)	22 (53.7)	9 (40.9)	15 (46.9)	13 (52)
Amoxicillin/Clavul Acid	13 (41.9)	14 (34.1)	11 (50)	14 (43.8)	7 (28)
Other	3 (9.7)	5 (12.2)	2 (9.1)	3 (9.4)	5 (20)
How long before incision is it administered?					
0-30 min	31 (100)	40 (97.6)	22 (100)	31 (96.9)	21 (84)
31-60min	0 (0)	1 (2.4)	0 (0)	1 (3.1)	2 (8)
>60min	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown	0 (0)	0 (0)	0 (0)	0 (0)	2 (8)
Do you prescribe post-operative Abx?	**N=124 n (%)**	**N=123 n (%)**	**N=57 n (%)**	**N=56 n (%)**	**N=35 n (%)**
Yes	42 (33.9)	30 (24.4)	25 (43.9)	33 (58.9)	14 (40)
Frequently (>70% cases)	12 (9.7)	18 (14.6)	8 (14)	7 (12.5)	8 (22.9)
Sometimes (<70% cases)	40 (32.2)	61 (49.6)	18 (31.6)	12 (21.4)	8 (22.9)
Never	30 (24.2)	14 (11.4)	6 (10.5)	4 (7.2)	5 (14.2)
Which post-operative Abx do you prescribe?	**N=94 n (%)**	**N=109 n (%)**	**N=51 n (%)**	**N=52 n (%)**	**N=30 n (%)**
First and second generation of cephalosporin	30 (31.9)	23 (21.1)	11 (21.6)	17 (32.7)	6 (20)
Amoxicillin/Clavul Acid	44 (46.8)	55 (50.5)	31 (60.8)	29 (55.8)	18 (60)
Other	20 (21.3)	27 (24.8)	8 (15.7)	5 (9.6)	5 (16.7)
Culture-driven	0 (0)	4 (3.7)	1 (2)	1 (1.9)	1 (3.3)
Duration of post-operative Abx?					
24h	1 (1.1)	0 (0)	1 (2)	1 (1.9)	1 (3.3)
1-7d	82 (87.2)	90 (82.6)	32 (62.7)	45 (86.6)	27 (90)
>7d	2 (2.1)	10 (9.2)	0 (0)	1 (1.9)	1 (3.3)
Time of splints/packs	9 (9.6)	9 (8.2)	18 (35.3)	5 (9.6)	1 (3.3)

Abx: antibiotics; Clavul: clavulanic; h: hours; d: days; min: minute; FESS: Functional Endoscopic Sinus Surgery; RSP: rhinoseptoplasty; ASBS: endoscopic anterior skull base surgery. Dosages and "Other" are represented in details in Supplementary Resource 2.

antibiotic prescribed (43.1%) (Supplementary Resource 2).
For open RSP, 57.1% of surgeons prescribed antibiotics before incision (Table 3). G1-2C at 1 g was the main way to prescribe (25%) followed by amoxicillin/clavulanate at 1 g (21.9%) (Supplementary Resource 2). Post-operatively, 71.4% of the open RSP surgeons prescribed antibiotics in all or most of their patients, 21.4% in some cases and 7.2% indicated they never prescribed antibiotics in the post-operative phase (Table 3). The most common post-operative antibiotic prescribed was amoxicillin/clavulanate 875/125 mg for 3x/d (38.5%) (Supplementary Resource 2).

Prophylactic antibiotic prescription in anterior skull base surgery

71.4% of surgeons performing endoscopic ASBS prescribed antibiotics before incision (Table 3) with the most common antibiotic given being G1-2C at 2 g (24%) (Supplementary Resource 2). 85.8% of the ASB surgeons prescribed post-operative antibiotics, with 40% systematically prescribing them in all patients. 14.2% of ASB surgeons never prescribed antibiotics in the post-operative phase (Table 3). The most frequent post-operative antibiotic prescribed was amoxicillin/clavulanate 875/125 mg 3x/d (36.7%) (Supplementary Resource 2).

Reasons for prescribing prophylactic antibiotics

The most common indication for prescribing peri-operative antibiotics mentioned by the respondents was prevention of post-operative infection (70.6%). This was followed by a reduction in the risk of bacteremia and TSS (40.5%), and prevention of splint- or pack-related infection (30.2%). Other indications included reduction of post-operative mucosal inflammation, scarring, synechiae, and crusting (26.3%). Reducing post-operative sinonasal symptoms, was reported by 11.1% of surgeons. 22.2%

Table 4. Reasons for prescribing antibiotics as mentioned by the ENT respondents (N=126).

Indications	n (%)
To prevent post-operative infection	89 (70.6)
To reduce risk of bacteremia and TSS	51 (40.5)
To prevent splint- or pack-related infection	38 (30.2)
To reduce post-operative mucosal inflammation / scarring / synechiae / crusting	33 (26.3)
Because I was taught to do so	28 (22.2)
To reduce post-operative sinonasal symptoms	14 (11.1)
Because of a previous bad experience	14 (11.1)

TSS: Toxic Shock Syndrome.

reported that they prescribed antibiotics because they were taught to do so, while 11.1% prescribed antibiotics because of a previous bad experience (Table 4).

Variables associated to antibiotic prescription habits

Regarding prophylactic antibiotics in septoplasty, two variables showed a significant relationship with prescription habits. First, ENTs working in academic settings were significantly less likely to prescribe intra-operative (10% vs. 31%, p=0.04) and post-operative antibiotics (16.7% vs 52.2%, p=0.002) compared to ENTs working in private practice (Figure 1A). Additionally, surgeons working in the French-speaking region were more likely to prescribe post-operative antibiotics than did surgeons practicing in the Dutch-speaking part (58.8% vs. 34.2%, p=0.01) (Figure 1A). The same geographic pattern was seen in FESS; with higher post-operative antibiotic use among French-speaking than Dutch-speaking surgeons (52.9% vs. 27.8%, p=0.008) (Figure 1B). The geographical trend was inversed for intra-operative management of open RSP and endoscopic ASBS, with Dutch-speaking practitioners more frequently administering intra-operative antibiotics (40.7% vs 72.4%, p=0.03 and p<0.001 respectively) than French-speaking surgeons (Figure 1D; data not shown for ASBS).

In FESS, also the use of packing/splinting was a significant variable; surgeons using post-operative packing prescribed more frequently antibiotics than those who did not. This was true for both the intra-operative setting (40.8% vs. 21.2%, p=0.031) as well as the post-operative setting (46.5% vs. 26.9%, p=0.038) (Figure 1B). For both types of RSP, the work setting was again a significant determinant for prescription of post-operative antibiotics that were more frequently prescribed by surgeons in private practice than by their academic colleagues in both closed (69% vs. 31.3%, p=0.027) and open RSP (90.9 vs. 54.5%, p=0.016) (Figure 1C and Figure 1D).

Other variables such as gender, age, years of experience, number of surgeries performed annually and the use of post-operative splints were not associated to antibiotic prescription habits in our survey (Figure 1).

Adherence to recommendations

Overall, 39.7% of respondents reported awareness of antibiotic recommendations in rhinologic surgery, with similar rates across academic (40.6%), private (38.8%), and mixed settings (40.7%). However, adherence to the 2018 AAO-HNS recommendations [10] was extremely low: only 6.3% of surgeons (n=126) complied with all recommendations. Among the 46 surgeons performing all procedure types (excluding endoscopic ASBS), just one (2.2%) adhered fully, including correct intra-operative timing, dosage, and antibiotic choice. When analyzing on the different types of surgery separately, the prescription habits matched recommendations better. Especially for intra-operative prophylaxis we found that 75%, 66.7% and 61.4% of respondents acted according to the recommendations for septoplasty, FESS and closed RSP respectively. For post-operative prophylaxis recommendations, these numbers dropped to 24.2%, 11.4%, 10.5% respectively (Table 5). These are rhinologic surgeries for which no antibiotics are recommended either intra-operatively or post-operatively according to AAO-HNS [10].

For open RSP, 8.9% of respondents prescribed intra-operative prophylaxis according to the recommendations and for ASBS they were followed by 17.1% (Table 5). Regarding post-operative management of open RSP and ASBS, only one surgeon matched the recommendations put forward by the AAO-HNS [10] (Table 5).

Discussion

This nationwide survey of Belgian ENT surgeons reveals significant variability and persistent overprescription of peri-operative antibiotics in rhinologic surgery, particularly post-operatively, despite recommendations showing limited or no benefit in most cases. The observed heterogeneity can be attributed to the lack of clear-cut evidence-based guidelines on antibiotic prophylaxis in rhinologic surgery. The AAO-HNS has developed the most comprehensive recommendations to date, based on a systematic review of the literature [10]. But even in this document, evidence levels are low for certain indications. National recommendations in various countries, such as the Netherlands [14], are typically coming from either Anesthesiology or Infectious Diseases societies and are often not regularly updated. The last recommendations given by the Infectious Diseases Society of America and Surgical Infection Society for clean-contaminated procedures except for FESS suggest to cover a broad-spectrum including anaerobes and gram-negative bacteria via the use of a metronidazole-cefazolin combination (grade B), but were published in 2013 and not updated since [9].

A key finding is the gap between practice and AAO-HNS recommendations. While 39.7% of surgeons were aware of the guide-

Table 5. Actual use of antibiotics by the ENT surgeons according to recommendations and awareness of their existence.

Surgery	Time	AAO-HNS 2018 recommendations (grade of recommendation)[10]	Adherence to recommendations	Awareness of recommendations about indications for Abx prophylaxis	
			V/W (%)	X/V (%)	Y/Z (%)
Septoplasty	Intra-op	No (A)	93/124 (75)	36/93 (38.7)	15/31 (48.4)
	Post-op	No (A)	30/124 (24.2)	14/30 (46.7)	9/42 (21.4)
FESS	Intra-op	No (D)	82/123 (66.7)	35/82 (42.7)	15/41 (36.6)
	Post-op	No (A)	14/123 (11.4)	7/14 (50)	14/30 (46.7)
Closed Rhinoplasty	Intra-op	No (B)	35/57 (61.4)	13/35 (37.1)	14/22 (63.6)
	Post-op	No (B)	6/57 (10.5)	4/6 (66.7)	13/25 (52)
Open Rhinoplasty	Intra-op	Yes (B) Cefazolin 2g (G1) 30-60 min prior to incision	5/56 (8.9)	4/5 (80)	7/24 (29.2)
	Post-op	Yes < 24 h (B)	1/56 (1.8)	1/1 (100)	2/4 (50)
ASBS	Intra-op	Yes (B) Cefazolin 2g (G1) 30-60 min prior to incision	6/35 (17.1)	4/6 (66.7)	3/10 (30)
	Post-op	No (B)	1/35 (2.9)	1/1 (100)	1/5 (20)

V: number of respondents that adhered to the recommendations [10]; W: total number of respondents that practiced the surgery; X: number of respondents that stuck to the recommendations [10] and that claimed to be aware of them [10]; Y: number of respondents that practiced against the recommendations [10] and that claimed to be aware of them [10]; Z: number of respondents that practiced against the recommendations [10]; AAO-HNS: American Association of Otolaryngology-Head & Neck Surgery; Abx: antibiotics; G1: first generation of cephalosporin; Intra-op: intra-operative antibiotic therapy; Post-op: post-operative antibiotic therapy; g: grams; min: minutes; h: hours; FESS: Functional Endoscopic Sinus Surgery; ASBS: endoscopic anterior skull base surgery

lines, only 6.3% adhered to them across all surgeries. Among those performing all four procedures (septoplasty, FESS, open and closed RSP; n=46), just one surgeon (2.2%) fully complied intra- and post-operatively regarding antibiotic type, dose and timing. Lack of adherence therefore concerns all surgeons, however diverse the rhinologic surgeries they undertake.

Notably, adherence was highest for intra-operative practices, particularly in septoplasty (75%) and FESS (66.7%), while post-operative adherence remained strikingly low across all procedures. This gap emphasizes the pressing need for standardized guidelines at both the international as the national levels, as well as enhanced dissemination and implementation by means of targeted educational interventions.

Although antibiotic choice varied, amoxicillin/clavulanate and G1-2C were most prescribed. G1-2C effectively cover typical nasal pathogens (*Staphylococcus aureus* (SA) and streptococci) with good tissue penetration, while amoxicillin/clavulanate offers broader coverage with similar properties. Given that most post-operative infections in rhinologic surgery are caused by SA, predominantly Methicillin-Susceptible-SA, it is both clinically and microbiologically sound to tailor prophylaxis toward this pathogen [15]. A narrow spectrum agent such as cefazolin provides adequate coverage in most cases. As the first-line prophylaxis agent, it should be preferred over broad-spectrum combinations like amoxicillin/clavulanate or second-generation cephalosporins, which can cause important side effects such as *Clostridioides difficile* intestinal opportunistic infections [16].

Interestingly, almost all responders administered their intra-operative antibiotics between 0 and 30 minutes prior to incision, while this should ideally be between 30-60 minutes to be effective during time of incision [10]. Regarding the duration of post-operative antibiotic courses, most surgeons reported prescribing antibiotics for 1 to 7 days. However, in cases where they are indicated (open RSP, ASBS), a duration of less than 24 hours is recommended [17-20]. This raises concerns about unnecessary prolonged exposure and its contribution to antimicrobial resistance.

The underlying motivations for prescribing antibiotics were for most surgeons the fear of post-operative infections and complications, although there is no evidence to support their prevention by antibiotic prophylaxis. They underscore the complex interplay between clinical judgment, empirical experience, and risk aversion. Interestingly, 22% of surgeons cited training tradition as a rationale, highlighting how historical practices may persist despite evolving evidence. Although not specifically queried in this study, overuse of prophylactic antibiotics could also be driven by perceived medico-legal risk [21,22], especially in otorhinolaryngology where standardization is limited, though

actual cases of negligence from omission are unreported; clear guidelines, education, tertiary settings, team-based care and supportive institutional culture help reduce defensive prescribing [23].

Geographical region of practice, institutional factors and the use of packing were the three significant determinants of prescribing behavior. ENT surgeons practicing in the French-speaking region of Belgium, mainly in the south of the country, were significantly more likely to prescribe post-operative antibiotics for septoplasty and FESS than their Dutch-speaking counterparts. The French-speaking surgeons also prescribed less intra-operative antibiotics for open RSP and ASBS. Both practices do not match the AAO-HNS recommendations [10]. This regional disparity is probably related to differences in training culture, but also adherence to different protocols, although the Société Française d'Anesthésie et Réanimation and the Société de Pathologie Infectieuse de Langue Française follow the AAO-HNS recommendations [24]. Secondly, we also found that surgeons working in academic settings, consistently prescribed fewer prophylactic antibiotics for septoplasty and RSP than those in private practice. This suggests that academic affiliation is often associated with greater adherence to evidence-based medicine or increased awareness of antimicrobial stewardship principles. Finally, the use of post-operative packing was also a significant predictor of prescribing more prophylactic antibiotics in FESS. This is possibly driven by the perceived increased risk of TSS or infection or medico-legal concerns. It should be highlighted that the AAO-HNS recommendations suggest that antibiotic prophylaxis can be considered if nasal packing is left in place for more than 48 hours [10]. In our survey, we didn't ask about the duration of the packing and therefore we cannot make any conclusions in that regard. Nevertheless, our results showed that over half of the surgeons still use non-resorbable packing in septoplasty/RSP and 39% in FESS. Around 70% of respondents reported using splints in septoplasty, closed and open RSP while only 7% used them in FESS. 30% of the responders mentioned that their reason for prescribing antibiotics was the fear for foreign-body related infection. In general, non-resorbable packing is applied in (rhino)septoplasty to prevent septal hematoma and in FESS to control bleeding. In FESS, it has been shown that non-resorbable packing is no more effective than resorbable packing for bleeding control (grade C), while both reduce synechiae [25], with resorbable packing being slightly more effective (grade B) [26]. It has been suggested that non-resorbable packing may increase infection risk in (rhino)septoplasty due to higher biofilm affinity [27,28], even though studies report no significant difference in infection rates between patients with or without packing [29,30]. When bleeding is minimal, splints may be used instead of packing to prevent septal hematoma, with the added benefits of better tolerability and lower biofilm formation [27,28]. Post-operative infection rates, however, are not significantly different between splints and packing [28,31]. To avoid septal hematoma in (rhino)septoplasty, transseptal sutures could be an alternative for splints/packing to overcome the presence of foreign body in the nose [32,33]. In the field of clean-contaminated abdominal [34] and obstetric [35] surgery, the use of antimicrobial-coated sutures (most commonly triclosan-impregnated) have been tested and have shown modest reductions in surgical site infections [36,37]. Although at his point, evidence in nasal surgery is lacking and efficacy may differ due to distinct microbiota, healing dynamics, wound type and suture material, this might be a promising option for the future to avoid post-operative infection in nasal surgery. Dedicated randomized trials are needed to define their efficacy, indications and cost-effectiveness for standardized guidelines. In conclusion, proper evidence-based guidelines for controlling post-operative bleeding and nasal hematoma are essential to reduce variability in practice and avoid unnecessary antibiotic prophylaxis.

Comparing our results with previous surveys, the association between nasal packing and post-operative antibiotics seen in an American FESS study [12] aligns with our findings, though not for septoplasty [11]. Unlike American data, where academic surgeons prescribed more antibiotics [12], Belgian academic surgeons adhered more closely to recommendations. In our study, years in practice was not associated to prescription habits as was seen by the study of Fang et al. (FESS) [12], nor did age or gender.

The strength of this study is that we obtained information on a substantial number of variables and a good distribution for almost all of them among our respondents, increasing the reliability of our findings. We also are the first to question the surgeons about their knowledge on the recommendations and to correlate our data with their responses. This study has several limitations that are quite inherent to survey studies. The most important limitation is the low response rate (15.3%). However, this response rate is comparable to similar survey studies [12, 13]. This, combined with the low number of Belgian ENT surgeons means that for certain surgeries, statistical analysis becomes less reliable due to the low number of surgeons in each group. This specifically holds true for the ASBS findings, since only 35 of the respondents were performing this kind of surgery. Secondly, there is the possibility of selection bias; it is possible that respondents with a particular interest in antibiotic stewardship or rhinologic surgery were more likely to participate. Additionally, the self-reported nature of the data may be subject to recall bias. The survey was circulated only twice over a two-week period; although a reminder was sent, increasing the number of circulations, personalizing email invitations, estimating the expected completion time and emphasizing the importance of the topic could have increased the response rate. However, we believe that this low response rate in combination with the selection bias, has led to an underestimation of the extent of

prophylactic antibiotic overuse in rhinologic surgery in Belgium and prophylactic prescriptions might be even higher than presented in this study.

Conclusions

Overall, our study shows wide variability and overuse of prophylactic antibiotics among rhinologic ENT surgeons, likely due to the lack of large-scale randomized trials and proper recommendations. It needs to be noted that since the publication of the systematic review that laid at the base of these recommendations, three recent studies have shown that a single intraoperative intravenous dose of cefuroxime significantly reduces post-operative infections in septoplasty in comparison with no prophylactic antibiotics [38]. These studies included patients that also underwent FESS [39] and received intranasal splints [40]. An update of the meta-analysis with a possible revision of the recommendations might therefore be indicated, at least for septoplasty.

Our findings highlight the need for large-scale prospective studies and internationally accepted guidelines, which could reduce unnecessary antibiotic use and improve future ENT care.

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Authorship contribution

KL: data analysis, intellectual analysis, tables and figures drafting, writing, reviewing of the manuscript, drafting revision. SK: survey design, data collection, writing, reviewing of the manuscript. JDG: intellectual analysis and reviewing of the manuscript. CB: intellectual analysis and reviewing of the manuscript. DL: statistics, figures drafting, reviewing of the manuscript. CDT: data collection and reviewing of the manuscript. PhR: data collection and reviewing of the manuscript. CH: intellectual analysis, data collection and reviewing of the manuscript. VH: survey design, data collection, data analysis, statistics, intellectual analysis, writing, reviewing of the manuscript, drafting revision, mentorship. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The survey was evaluated by an independent ethics committee, the Comité d'Ethique Hospitalo-Facultaire Saint-Luc – UCLouvain, which issued a favourable opinion.

Consent for publication

Not applicable.

Availability of data and material

All data generated or analysed during this study are included in this published article and its supplementary information files.

Conflict of interest

VH has received consultancy and speaker fees from ALK, GSK, Sanofi, Novartis and Celltrion. The remaining authors declare no conflicts of interest.

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SUPPLEMENTARY MATERIALS

Supplementary Resource 1. Survey questions.

1. In which age bracket do you fall?

a. <40 years old
b. 41-50 years old
c. 51-60 years
d. >60 years

2. How long have you been in practice (including residency)?

a. 0-5 years
b. 6-10 years
c. 11-15 years
d. 16-20 years
e. >20 years

3. What is your gender?

a. Female
b. Male
c. I do not wish to answer

4. Where do you work?

a. In a university hospital
b. In an independent or private setting
c. A combination of both

5. Can you estimate how many of the following procedures you perform (and/or assist) per year?

Septoplasty:

a. None
b. 1-10
c. 11-50
d. >50

Functional endoscopic sinus surgery (FESS):

a. None
b. 1-10
c. 11-50
d. >50

Closed rhinoplasty:

a. None
b. 1-10
c. 11-50
d. >50

Open rhinoplasty:

a. None
b. 1-10
c. 11-50
d. >50

Endoscopic anterior skull base surgery (ASBS):

a. None
b. 1-10
c. 11-50
d. >50

6. What kind of packing/splints do you usually use for the following procedures?

Septoplasty:

a. Non-resorbable packing
b. Resorbable packing
c. Silastics/Doyle
d. Other, please specify
e. None

Functional endoscopic sinus surgery (FESS):

a. Non-resorbable packing
b. Resorbable packing
c. Silastics/Doyle
d. Other, please specify
e. None

Closed rhinoplasty:

a. Non-resorbable packing
b. Resorbable packing
c. Silastics/Doyle
d. Other, please specify
e. None

Open rhinoplasty:

a. Non-resorbable packing
b. Resorbable packing
c. Silastics/Doyle
d. Other, please specify
e. None

Endoscopic anterior skull base surgery (ASBS):

a. Non-resorbable packing
b. Resorbable packing
c. Silastics/Doyle
d. Other, please specify
e. None

7. Do you usually give antibiotics before starting surgery for the following procedures?

Septoplasty:

a. Yes
b. No

Functional endoscopic sinus surgery (FESS):

a. Yes
b. No

Closed rhinoplasty:

a. Yes
b. No

Open rhinoplasty:

a. Yes
b. No

Endoscopic anterior skull base surgery (ASBS):

a. Yes
b. No

If yes,

- *What type of antibiotic do you give?*
- *At what dose?*
- *How long before incision is it given?*

a. 0 - 30 min
b. 31 - 60 min
c. >60 min
d. I don't know

8. How often do you prescribe post-operative antibiotics for the following procedures?

Septoplasty:

a. Always
b. Often (> 70% of the time)
c. Sometimes (30 to 70% of the time)
d. Rarely
e. Never

Functional endoscopic sinus surgery (FESS):

a. Always
b. Often (> 70% of the time)
c. Sometimes (30 to 70% of the time)
d. Rarely
e. Never

Closed rhinoplasty:

a. Always
b. Often (> 70% of the time)
c. Sometimes (30 to 70% of the time)
d. Rarely
e. Never

Open rhinoplasty:

a. Always
b. Often (> 70% of the time)
c. Sometimes (30 to 70% of the time)
d. Rarely
e. Never

Endoscopic anterior skull base surgery (ASBS):

a. Always
b. Often (> 70% of the time)
c. Sometimes (30 to 70% of the time)
d. Rarely
e. Never

If you prescribe post-operative antibiotics and for the different surgeries,

- *What type of antibiotic do you prescribe?*
- *At what dose?*
- *For how long do you prescribe antibiotics?*

a. Duration of packing
b. <7 days
c. >7 days

9. Why do you prescribe peri-operative antibiotics? Please check all items that apply to your practice.

a. To reduce the risk of bacteremia and toxic shock syn drome
b. To prevent post-operative infections
c. To reduce mucosal inflammation, scarring, synechiae and post-operative scabs
d. To reduce post-operative sinonasal symptom
e. Because I was taught to
f. To prevent packing-related infections
g. Because of a bad experience in the past
h. Other (please specify)

10. Are you aware of any guidelines for the use of antibiotics in rhinology surgery?

a. Yes
b. No

Supplementary Resource 2. Detailed description of peri-operative antibiotics prescribed, as mentioned by prescribers in the survey.

	Septoplasty	FESS	Closed RSP	Open RSP	ASBS
Which intra-operative Abx do you prescribe ?	**N=31 n (%)**	**N=41 n (%)**	**N=22 n (%)**	**N=32 n (%)**	**N=25 n (%)**
G1-2 Ceph, 1g	6 (19.4)	6 (14.6)	7 (31.8)	8 (25)	3 (12)
G1-2 Ceph, 1.5g	1 (3.2)	1 (2.4)	0 (0)	0 (0)	0 (0)
G1-2 Ceph, 2g	6 (19.4)	9 (22)	2 (9.1)	5 (15.6)	6 (24)
G1-2 Ceph, dosage depending on the anesthetist	1 (3.2)	1 (2.4)	0 (0)	0 (0)	0 (0)
G1-2 Ceph, dosage unknown	1 (3.2)	5 (12.2)	0 (0)	2 (6.3)	4 (16)
Combination of G1-2 Ceph, 2g and Metronidazole, 500mg	0 (0)	0 (0)	0 (0)	1 (3.1)	2 (8)
Amox/Clav, 1g	8 (25.8)	7 (17.1)	5 (22.7)	7 (21.9)	2 (8)
Amox/Clav, 1.5g	0 (0)	0 (0)	1 (4.6)	1 (3.1)	0 (0)
Amox/Clav, 2g	3 (9.7)	5 (12.2)	2 (9.1)	4 (12.5)	2 (8)
Amox/Clav, 3g	2 (6.5)	2 (4.9)	2 (9.1)	1 (3.1)	1 (4)
Amox/Clav, dosage unknown	0 (0)	0 (0)	1 (4.6)	1 (3.1)	2 (8)
Amox/Clav or G1-2 Ceph, dosage unknown	0 (0)	1 (2.4)	0 (0)	0 (0)	1 (4)
Amox, 1g	1 (3.2)	0 (0)	0 (0)	0 (0)	0 (0)
Amox, 1.5g	0 (0)	1 (2.4)	0 (0)	0 (0)	0 (0)
Depending on the other specialists except anesthesiology (internal medicine, neurosurgery)	1 (3.2)	1 (2.4)	1 (4.6)	1 (3.1)	1 (4)
Unknown	1 (3.2)	2 (4.9)	1 (4.6)	1 (3.1)	1 (4)
Which post-operative Abx do you prescribe?	**N=94 n (%)**	**N=109 n (%)**	**N=51 n (%)**	**N=52 n (%)**	**N=30 n (%)**
G1-2 Ceph, 500mg 1x/d	1 (1.1)	2 (1.8)	0 (0)	0 (0)	0 (0)
G1-2 Ceph, 500mg 2x/d	11 (11.7)	7 (6.4)	4 (7.8)	7 (13.5)	2 (6.7)
G1-2 Ceph, 500mg 3x/d	16 (17)	14 (12.8)	6 (11.8)	9 (17.3)	3 (10)
G1-2 Ceph, IV 1g every 8h on 24h	1 (1.1)	0 (0)	1 (2)	1 (1.9)	1 (3.3)
G1-2 Ceph, dosage unknown	1 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)
Amox/Clav, 875/125mg 1x/d	2 (2.1)	6 (5.5)	4 (7.8)	4 (7.7)	3 (10)
Amox/Clav, 875/125mg 2x/d	2 (2.1)	1 (0.9)	2 (3.9)	1 (1.9)	0 (0)
Amox/Clav, 875/125mg 3x/d	34 (36.2)	43 (39.4)	22 (43.1)	20 (38.5)	11 (36.7)
Amox/Clav 875/125mg 4x/d	0 (0)	0 (0)	0 (0)	0 (0)	3 (10)
Amox/Clav, 500/125mg 1x/d	1 (1.1)	1 (0.9)	0 (0)	0 (0)	0 (0)
Amox/Clav, 500/125mg 3x/d	4 (4.3)	4 (3.7)	3 (5.9)	4 (7.7)	0 (0)
Amox/Clav, dosage unknown	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (3.3)
Amox, 500mg 3x/d	2 (2.1)	2 (1.8)	0 (0)	0 (0)	1 (3.3)
Amox, 500mg 4x/d	0 (0)	1 (0.9)	0 (0)	0 (0)	0 (0)
Amox, 750mg 3x/d	1 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)
Amox, 1g 3x/d	4 (4.3)	0 (0)	1 (2)	0 (0)	0 (0)
Amox, dosage unknown	1 (1.1)	0 (0)	1 (2)	0 (0)	0 (0)
Flucloxacilin, 500mg 2x/d	1 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)
Clarithromycin, various dosage	0 (0)	3 (2.8)	0 (0)	0 (0)	0 (0)
Doxycyclin, various dosage	1 (1.1)	2 (1.8)	0 (0)	0 (0)	0 (0)
Amox/Clav or G1-2 Ceph, dosage unknown	2 (2.1)	0 (0)	1 (2)	1 (1.9)	0 (0)
Amox/Clav or Clindamycin, dosage unknown	0 (0)	0 (0)	1 (2)	1 (1.9)	0 (0)
Amox, 1g 3x/d or G1-2 Ceph, 500mg 3x/d	0 (0)	1 (0.9)	0 (0)	0 (0)	0 (0)
Amox/Clav, 875/125mg 3x/d or Amox, 1g 3x/d	0 (0)	1 (0.9)	0 (0)	0 (0)	0 (0)
Amox/Clav or Doxycyclin if CRSwNP, various dosage	0 (0)	3 (2.8)	0 (0)	0 (0)	0 (0)

	Septoplasty	FESS	Closed RSP	Open RSP	ASBS
Azithromycin, 250mg 3x/d or Doxycyclin, 100mg 1x/d	0 (0)	1 (0.9)	0 (0)	0 (0)	0 (0)
Local antibiotics, dosage unknown	1 (1.1)	1 (0.9)	0 (0)	0 (0)	0 (0)
Depending on neurosurgery	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.3)
Culture-driven	0 (0)	4 (3.7)	1 (2)	1 (1.9)	1 (3.3)
Unknown	7 (7.4)	12 (11)	4 (7.8)	3 (5.8)	3 (10)

Abx: antibiotics; Ceph: cephalosporin; Amox: amoxicillin; Clav: clavulanate; G1-2: first or second generation; g: gram; mg: milligram; x/: per; h: hours; d: days; IV : intravenous ; CRSwNP : chronic rhinosinusitis with nasal polyps; FESS: Functional Endoscopic Sinus Surgery; RSP: rhinoseptoplasty; ASBS: endoscopic anterior skull base surgery.