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BRIEF COMMUNICATION

THE BACTERIOLOGY OF RHINOSINUSITIS AT FELEGE HIWOT REFERRAL HOSPITAL, BAHIR DAR, ETHIOPIA

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ABSTRACT

Background: *Bacterial sinusitis is caused by S. pneumoniae, S. pyogenes, H. influenzae, M. catarrhalis and anaerobic bacteria whose treatment has become highly difficult because of increased antimicrobial resistance rates.*
Objectives: *The study was aimed to determine the bacteriology of rhinosinusitis at Felege Hiwot Referral Hospital, North West, Ethiopia.*
Methods: *A retrospective study was conducted on nasal discharge cultures and socio-demographic data of age, sex, and patient settings; bacteriological analysis were processed from September 2003 to June 2007. Data were retrieved from patient records from July 01- 30, 2008. Antibiotic sensitivity testing was done using the disc diffusion method.*
Results: *Of the 288 nasal discharges, 162 (56.3%) were from male patients. Of the total cultures, 112 (38.9%) were found culture positive. The most predominant bacteria isolates were S. aureus 75 (67%), Klebsiella species 11 (9.8%), and Coagulase negative staphylococci 10 (8.9%). One hundred and three (92%) isolates were resistant to two or more antimicrobial agents. The highest resistance rates were observed for ampicillin 100 (89.3%), penicillin G 80 (71.4%), and tetracycline 79 (70.5%), whereas the least resistance rates were observed for gentamicin, 17 (15.2%).*
Conclusion: *In the study area, antimicrobial resistances were very high for bacterial isolates of nasal discharges. It was noticed that the frequently involved bacteria in rhinosinusitis were not recovered. Thus, further studies on bacteriology of rhinosinusitis need to be conducted for appropriate antimicrobial therapy.*

Keywords: *Antimicrobial resistance, rhinosinusitis, Ethiopia.*

INTRODUCTION

Sinusitis is an infection or inflammatory condition involving maxillary, ethmoid, frontal and sphenoid structures of the nasal cavity. Sinusitis can be classified by the structure of sinus cavity, duration of illness and by etiology as infectious and non infectious sinusitis. It is often a sequela of upper respiratory tract infections(1). Sinusitis is the fifth leading diagnosis for which antibiotics are prescribed (2).

The nasopharynx serves as the reservoir for anaerobic bacteria and pathogenic bacteria that can cause respiratory infections, including sinusitis. Although the bacteriology of acute and chronic infectious sinusitis has been well determined, there are discrepancies on bacterial etiology of acute and chronic sinusitis. Studies indicated that the major bacterial species causing acute and chronic infectious sinusitis are aerobic, anaerobic, and facultative anaerobic bacteria (3-6). The major pathogens of acute infectious sinusitis are *S. pneumoniae*, *H. influenzae*, and *M. catarrhalis* whereas the predominant bacterial isolates for chronic infectious sinusitis are anaerobic bacteria (7-8). However, Hsu J *et al* isolated *S. aureus* and enteric gram negative bacilli from chronic sinusitis (9).

Recent studies showed that a high percentage of episodes for respiratory tract infections have been

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treated with antibiotics (6). However, antibiotic resistance continues to be detrimental to the delivery of effective treatment because of a high prevalence of multidrug-resistant strains among respiratory pathogens (6).

Studies have shown that the devastating causes of drug resistance in the past 10 to 15 years were: inappropriate prescribing of antibiotics for viral respiratory tract infections, patients use of antibiotics prescribed for another person or use of antibiotics left over from a previous illness, or interruptions (10-14). It can significantly complicate the effective treatment of community-acquired respiratory tract infections, such as rhinosinusitis, community acquired pneumonia, otitis media and acute exacerbation of chronic bronchitis.

Although antibiotic resistance has been spreading over recent years, there is great variation between different locations that have been studied. Determining the bacteriology of sinusitis has practical importance as it can guide in choosing the proper antimicrobial therapy. Therefore, to determine the bacteriology of nasal discharges, a retrospective study was undertaken on records of nasal discharge cultures that were processed for five years at Felege Hiwot Referral Hospital, Ethiopia.

MATERIALS AND METHODS

Study design: A retrospective study was conducted on nasal discharges culture records that were processed from patients with purulent nasal discharges at Felege Hiwot Hospital, Bahir Dar, from September 2003 to June 2007. Socio-demographic data of age, sex, patient settings and bacteriology were collected from patient records from July 01- 30, 2008.

Bacterial identification: According to the standard operating procedures, purulent nasal discharges were collected with sterile cotton swabs after opening the nostrils of patients. Specimens were inoculated onto 5% sheep blood, chocolate agar, manitol salt agar and MacConkey agar plates (Oxoid, Hampshire, England). The plates were incubated at 37 $^{0}_{C}$ aerobically (MacConkey, manitol salt agar) and under 5% carbon dioxide, (5% sheep blood and chocolate); bacterial species were identified after 24 hours (15).

Antimicrobial susceptibility testing: The standard operating procedures showed that antimicrobial susceptibility tests were done on Mueller-Hinton agar (Oxoid, Hampshire, England) by the disc-diffusion method (16). The following antimicrobial agents were employed: ampicillin (10mg), chloramphenicol (30µg), gentamicn(10mg), penicillin G (10units), tetracycline (30mg), erythromycin (30mg), co-trimoxazole (25mg), streptomycin (10 µg), carbenicillin (100 µg), and cephalotin (30 µg).

Morphologically identical 3 to 5 bacterial colonies from cultures were suspended in 5ml Muller Hinton broth and incubated for 4 hours at 37^{o}C. Turbidity of the broth culture was equilibrated to match with 0.5 McFarland standards. Then, a loop full of this bacterial suspension was placed at the center of the Muller Hinton agar medium and evenly spread using dry cotton swabs. Resistance data were interpreted according to the National Committee for Clinical laboratory Standards (17). Reference strains *E. Coli* ATCC 25922 and S. *aureus* ATCC 25923 were used as controls. Data were analyzed by the SPSS version 16 statistical package. The study was approved by the Research Ethics Committee of the Bahir Dar University.

Sociodemographic and other relevant data were collected using a pre-tested and well-structured questionnaire. Data collection and bacteriological analysis were made by a well-trained laboratory technician under the supervision of the investigators. Data were entered and analyzed using the SPSS version 13 soft ware.

RESULTS

Nasal discharges from 288 patients (162 males and 126 females) were studied. Their mean age was 32 years ranging from 2 months to 69 years of age. Two hundred and thirty-six (82%) of the nasal discharges were obtained from outpatients (Table 1). The overall isolation rate of bacterial pathogens was 112 (38.9%). The predominant bacterial isolates were *S. aureus* 75 (67%) followed by *Klebsiella* spp11 (9.8%) and Coagulase negative Staphylococcus spp 10 (8.9 %), and *Proteus* species 9 (8%), while other species of the genera of Enterobactericeae showed lower prevalence (Table 2).

Table 1: Sociodemographic characteristics of patients with nasal discharge cultures at Felege Hiwot Referral Hospital, 2003-2007.

Variable	Frequency n (%)	Culture positive n (%)
Age group (years)		
<5 years	12 (4.2)	9 (75)
5-15 years	23 (8)	11 (48.8)
16-48	232 (80.5)	80 (34.5)
≥49	21 (7.3)	12 (57.1)
Sex		
Female	126 (43.7)	50 (39.7)
Male	162 (56.3)	62 (38.3)
Patient settings		
Out patient	236 (82)	84 (35.6)
Wards	52 (18)	28 (53.8)
Total	288 (100)	112 (38.9)

Table 2. Multi-antibiotic resistance of nasal discharge isolates at Felege Hiwot Referral Hospital, Ethiopia, 2003-2007.

Bacterial species	Isolates N0 (%)	Antibiogram					
		R_0	R_1	R_2	R_3	R_4	R_5
S. aureus	75 (67)	-	8 (10.7)	7 (9.3)	13 (17.3)	23 (30.7)	24 (32)
Klebsilla spp	11 (9.8)	-	-	2 (18)	1 (9)	1 (9)	7 (64)
CNS*	10 (8.9)	-	-	-	2 (20)	3 (30)	5 (50)
Proteus spp	9 (8)	-	1 (11)	1 (11)	-	4 (44.7)	3 (33.3)
Providencia spp.	1 (0.9)	-	-	1(100)	-	-	-
Pseudomonas spp	1 (0.9)	-	-	1(100)	-	-	-
Entrobacter spp	3 (2.7)	-	-	-	-	1 (33.3)	2 (66.6)
E. coli	2 (1.8)	-	-	-	-	-	2 (100)
Total	112 (100)	-	9 (8)	12 (10.7)	16 (14.3)	32 (28.6)	43 (38.4)

***Key**: R_0-Sensitive to all antibiotics, R_1-Resistance to one antibiotic, R_2-Resistance to two antibiotics, R_4-Resistance to three antibiotics, R_4-Resistance to four antibiotics, R_5-Resistance to five antibiotics.*
CNS Coagulase negative Staphylococcus*

The highest resistance rates were recorded for ampicillin 100 (89.3%), penicillin G 80 (71.4%), and tetracycline 79 (70.5%). *S. aureus* had the highest resistance rate to penicillin, ampicillin and tetracycline, whereas the least resistanance rates were observed for gentamicin and cephalotin. The antimicrobial resistance rates of each bacterial species to each antimicrobial tested is summarized in (Table 3). All bacterial isolates showed resistance to one or more antimicrobial agents. One hundred and three (92%) of the isolates showed resistance to two and more antimicrobial agents (Table 2).

Table 3. Antimicrobial resistance patterns of nasal discharge isolates, at Felege Hiwot Referral Hospital, Ethiopia, 2003-2007.

Organisms tested	**Frequency No (%)**	**Antimicrobial agents tested number (%)**									
		Amp	GN	P	TE	C	E	SXT	S	CAR	CEP
S. aureus	75 (67)	68 (90.6)	12 (16)	71 (95)	64 (85)	38 (50)	29 (38.6)	45 (60)	42 (56)	42 (56)	19 (25.3)
Klebsilla spp	11 (9.8)	10 (90.9)	2 (18.2)	*	5 (45)	6 (54.5)	-	5 (45.5)	10 (90.9)	7 (63.6)	9 (81.8)
CNS	10 (8.9)	8 (80)	-	9 (90)	-	5 (50)	7 (70)	-	5 (50)	-	4 (40)
Proteus spp	9 (8)	8 (88.9)	2 (22)	*	8 (88)	6 (66.6)	4 (44)	5 (55.5)	7 (77.7)	4 (44)	2 (22)
Providencia spp	1 (0.9)	1 (100)	-	*	1 (100)	-	-	-	1 (100)	1 (100)	-
Pseudomonas spp	1 (0.9)	1(100)	-	*	1 (100)	-	-	1 (100)	1 (100)	-	*
Entrobacter spp	3 (2.7)	2 (66.6)	-	*	-	-	*	1 (33.3)	2 (66.6)	-	-
E. coli	2 (1.8)	2 (100)	1 (50)	*	2 (100)	2 (100)	*	2 (100)	1 (100)	-	*
Total	112 (100)	100 (89.3)	17 (15.2)	80 (71.4)	79 (70.5)	57 (51)	40 (35.7)	59 (52.6)	69 (61.6)	54 (48.2)	34 (30.4)

***Key**: Amp, Ampicilin, GN: Gentamycin, P:Penicillin, TE: Tetracycline, C: Chloramphenicol, E:Erythromycin, SXT: Co-trimoxazole, S: Streptomycin, CAR: Carbenicillin, CEP: Cephalotin*

** No susceptibility testing done*

DISCUSSION

An important observation in this study was the absence of the major bacterial pathogens of sinusitis, such as *S. pneumoniae S. pyogenes, H. influenzae*, and *M. catarrhalis*. This is inconsistent with the findings of other relevant studies which recovered the above bacterial species frequently in rhinosinusitis (2, 9). These bacteria accounted for 50-60 % of the acute infectious sinusitis (1). The lack of recovery may be due to inappropriate specimen collection and/ or transport or effects of previous antimicrobial therapy (8).

In this study, 112 (39%) of the nasal discharges were found culture positive for bacterial species. The isolation rate among children (≤ 15 years) was higher (57%) compared to adults (36%), but no significant difference in gender was noted (Table 1). In our case, the overall (39%) rate was lower compared to other studies which reported that 76 % of nasal discharges were culture positive for bacterial pathogens (2,9). The reason for a lower isolation rate in this study may be failure of recovering *S. pneumoniae, S. pyogenes, M. catarrhalis, H. influenzae,* and anaerobic bacteria (8).

The most frequently isolated organisms were *S. aureus* and species of some Enterobacteriacae (Table 2). However, Brook et *al* reported that anaerobic bacteria followed by Enterobacteriaceae and *S. aureus* were predominant from chronic sinusitis (18). Moreover, studies in the past reported that in chronic sinusitis, *S. aureus, S. epidermidis* and gram negative bacilli along with anaerobic bacteria were recovered (9, 19).

The treatment of bacterial sinusitis has become more difficult because of the increased antimicrobial resistance of the major pathogens recovered in acute and chronic infections. Information on antimicrobial resistant patterns of bacteria in the community and effects of previous antibiotic exposures are essential in the selection of antimicrobial agents in the therapy of sinusitis (20). In this study, single and multiple antimicrobial resistances against commonly prescribed antimicrobial agents were very high among bacterial isolates of sinusitis (Table 3).

The most frequent isolate, *S. aureus,* showed an increased antimicrobial resistance to commonly prescribed antimicrobial agents as shown in (Table 2). This is in agreement with the study conducted in southern Ethiopia (21) and elsewhere. In the same study area, Bayeh *et al* reported high rates of methicillin-resistant *S. aureus* (59.7%) (22). However, it was higher than the report of a study in Gondar (23).

The gram-negative isolates, *Klebsiella* spp, *proteus* spp, *pseudomonas* spp, providencia spp, and *E. coli* were highly resistant to ampicilin and streptomycin ranging from 88-100% but susceptible to gentamicine. *E. coli*, *proteus* spp and *pseudomonas* spp showed a high resistance to cotrimoxazole (Table3). These resistance patterns were in line with species of Enterobacteriaceae isolates of different body sites (21). Since it was a retrospective study, the clinical information of the patients was not reviewed. Therefore, we could not determine to associate the isolated bacterial species against acute and chronic sinusitis and with multiple sinuses.

In conclusion, Staphylococci and six species of enteric gram negative bacilli were isolated from nasal discharges. Single and multiple antimicrobial resistances to the commonly used antibiotics were very high among bacterial isolates from nasal discharges. However, the commonly involved bacteria, such as *S. pneumoniae S. pyogenes, H. influenzae, M. catarrhalis,* and anaerobic bacteria were not recovered. Further studies on bacteriology of rhinosinusitis need to be conducted to determine the effect of antimicrobial therapy.

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REFERENCES

1. Harrison TR, Resnick Wr, Wintrobe MM, Thorn GW, Adams RD, Beeson PB *et al* . Respiratory tract infections: Harrisons' principles of internal medicine, 16th ed. New York: McGraw-Hill; 2005: 185-188
2. Brook I. Discrepancies in the recovery of bacteria from multiple sinuses in acute and chronic sinusitis. Journal of Medical Microbiology,2004; 53 :879–885

3. Cristiana M. Nascimento-Carvalho. Outpatient antibiotic therapy as a predisposing factor for bacterial resistance: a rational approach to airway infections. J Pediatr, 2006; 82(5):146-52.
4. Masatoshi K, Shunkichi B, Haruki M, Kohei H, Fumio M, Kimitaka K *et al.* Study of nasopharyngeal bacterial flora. Second report. Variations in nasopharyngeal bacterial flora in children aged 6 years or younger when administered antimicrobial agents. Part 2. J Infect Chemother, 2006; 12:305–330.
5. Simon HB. Bacterial infections of the upper respiratory tract. J Sci Am Med 2006; 7 (19):1-11.
6. Kang C, Kim S, Park W, Lee K, Kim H, Kim E, *et al.* Bloodstream infections caused by antibiotic -resistant gram-negative bacilli: Risk factors for mortality and impact of inappropriate initial antimicrobial therapy on outcome. J Antimicrob Agents Chemother. 2005; 49 (9):3980-1.
7. Jousimies-Somer HR, Savolainen S, Ylikoski JS. Bacteriological findings of acute maxillary sinusitis in young adults. *J Clin Microbiol.* 1988;26:1919-1925
8. Nord CE. The role of anaerobic bacteria in recurrent episodes of sinusitis and tonsillitis. *Clin Infect Dis.* 1995; 20:1512-1524.
9. Hsu J, Lanza DC, Kennedy DW. Antimicrobial resistance in bacterial chronic sinusitis. Am J Rhinol.1998; 12(4):243-8
10. Moellering RC, Craig W, Edmond M, *et al*; Consensus Working Group. Clinical and public health implications of macrolide-resistant*Streptococcus pneumoniae*. J Chemother, 2002; 14 (l 3):42–56.
11. Doern GV. Antimicrobial resistance with bacterial causes of community-acquired respiratory tract infections in the United States. Treat Respir Med. 2005; 4 (1):1–4.
12. Lonks JR, Garau J, Medeiros AA. Implications of antimicrobial resistance in the empirical treatment of community-acquired respiratory tract infections: The case of macrolides. J Antimicrob Chemother, 2002; 50 (2); 87–92.
13. Jacobs MR. Worldwide trends in antimicrobial resistance among common respiratory tract pathogens in children. J Pediatr Infect Dis. 2003; 22 (8):109-119.
14. Vanderkooi OG, Low DE, Green K, *et al.* Predicting antimicrobial resistance in invasive pneumococcal infections. Clin Infect Dis. 2005; 40:1288–97.
15. Basic Laboratory Procedures in Clinical Bacteriology. 2nd edition, WHO, Geneva 2003;37-50
16. Mattias L, Göran K, Nguyen T CH, *et al.* Antibiotic medication and bacterial resistance to antibiotics: a survey of children in a Vietnamese community. Topical Medicine & International Health. 2000; 5 (10): 711 – 721.
17. National Committee for Clinical Laboratory Standards (NCCLS) performance standards for antimicrobial susceptibility testing approved standard M100-S9. 1999; Wayne, A.
18. Brook I. Bacteriology of chronic sinusitis and acute exacerbation of chronic sinusitis. Arch Otolaryngol Head and Surg. 2006; 132 (10): 1099-10101
19. Brook I. Bacterial infection antibiotic treatment in chronic rhinosinusitis. Clin Allergy Immuno. 2007; 20: 147-62
20. Jacobs MR. Worldwide trends in antimicrobial resistance among common respiratory tract pathogens in children. J Pediatr Infect Dis. 2003; 22 (8): 109-119.
21. Gebre-Selassie S. Antimicrobial resistance of clinical bacterial isolates in Southern Ethiopia .Ethiop Med J, 2007; 45 (4):363-375
22. Abera B, Alem A, and Bezabih B. Methicillin-resistant strains of *staphylococcus aureus* and coagulase-negative staphylococcus from clinical isolates at Felege Hiwot referral hospital, North West Ethiopia, *Ethiop Med J.* 2008; 46(2):149-153.
23. Yismaw G, Tirunh M, Kassu A, Negeri C, Mulu, A. Retrospective analysis of prevalence and antimicrobial susceptibility patterns of *staphylococcus aureus* in Gondar teaching hospital,2001-2005, *Ethiop Med. J.* 2008; 46(2):143-148.