# Adenoid microbiology: expanded role of resistant S. aureus

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**Objectives:** ***1) Learn the bacterial growth and resistance patterns from adenoidectomy specimens 2) correlate growth and resistance patterns with a patient subgroup analysis.***

**Patients:** ***Children between the ages of 2 months and 12 years undergoing an adenoidectomy at a tertiary academic ambulatory referral surgical center***

**Methods:** ***Retrospective cohort analysis. Core adenoid tissue was cultured for aerobic and anaerobic bacteria, and bacterial isolates were compared between subgroups***

**Results:** ***Interestingly, Staph aureus (32%) was grown in higher numbers than S. pneumoniae (23%), M. catarrhalis (19%), or H. influenzae (13%) Sensitivity testing revealed 25% of S. aureus isolates to be methicillin resistant (MRSA, 8% of all patients), and an additional 60% were penicillin resistant (19% of all patients). Qualitative and quantitative analysis of potentially pathogenic bacteria revealed no significant differences between groups, however there was a trend for higher number of MRSA in patients with chronic adenoiditis versus those with adenoid hypertrophy.***

**Conclusions:** ***Knowledge of common bacteria and resistance patterns guides antimicrobial therapy. Amoxicillin is currently the first-line treatment for many conditions tied directly to adenoid microbiology, therefore the bacteria and resistance patterns of diseased adenoid tissue should be revisited with particular attention to the expanding role of resistant strains of S. aureus.***

**Keywords:** ***Adenoid, culture, S. aureus, resistance.***

## INTRODUCTION

Adenoid bacteriology has been implicated in multiple infectious and non-infectious diseases of the head and neck, including chronic otitis media, adenoid hypertrophy with obstruction, adenotonsillitis, and rhinosinusitis. Given the prevalence of these diseases, establishing the bacteriology of adenoid tissue has important implications in the management of these conditions. While many studies have explored this topic,[1-4] the majority are decades old, and have preceded the recent rise in community-acquired MRSA. Furthermore, many of these studies failed to evaluate anaerobic bacteria and used insensitive culture methods compared with current technology.

Recent studies have shown a rise in the incidence of methicillin resistant Staph aureus (MRSA) in pediatric infectious diseases of the head and neck, as well as other body areas. Consequently, we looked to update our

knowledge of the bacteriology of diseased adenoid tissue, and explore whether the trend toward increasing numbers of resistant S. aureus isolates carries over toward adenoid microbiology as well. Our primary objectives were to; 1) learn the most common bacteria cultured from diseased adenoid tissue in our patient population, 2) learn the resistance patterns of these bacteria and 3) compare bacteriology profiles between different adenoid disease patterns.

## PATIENTS AND METHODS

Appropriate institutional review board approval for the study was obtained. Patients between the ages of 2 months and 12 years who were scheduled to undergo an adenoidectomy either with or without concomitant surgical procedures were included. Patients were excluded if they had any history of prior adenoid surgery, craniofacial abnormalities, congenital or acquired immunodeficiency, or if they had undergone previous antibiotic treatment within the past 3 weeks. During surgery a curette was used to take a sample of adenoid tissue, which was then sent to pathology for aerobic and anaerobic culture and sensitivity.

Pre-operative and post-operative diagnosis, age, co-morbidities, adenoid size, as well as any concomitant procedures performed were recorded. Culture results were recorded including any bacteria cultured (aerobic and anaerobic) as well as antibiotic sensitivities. Growth was recorded qualitatively as 1-4+ based on our institution's pathologic guidelines. We registered isolates in a database along with sensitivity information, removing identifiable patient information, and compared the bacteria isolated (both qualitatively and quantitatively) between groups. Statistical calculations were performed using a t-test with significance determined as a p value of $<0.05$.

## RESULTS

At the time of submission, 154 patients were included for analysis. Multiple potentially pathogenic organisms were grown including S. pneumoniae (22%), M.catarrhalis (19%), and H. influenzae (13%) (Table 1, Fig. 1). Interestingly, S. aureus (32%) was grown in higher numbers than S. pneumoniae, H. influenzae or M. catarrhalis (Table1). Additionally, of the S. aureus isolates that were grown, 25% were methicillin-resistant (MRSA, 8% of all patients) and 60% were penicillin-resistant (19% of all patients). Therefore 84% of the S. aureus cultured were either MRSA or penicillin resistant (Fig. 2).

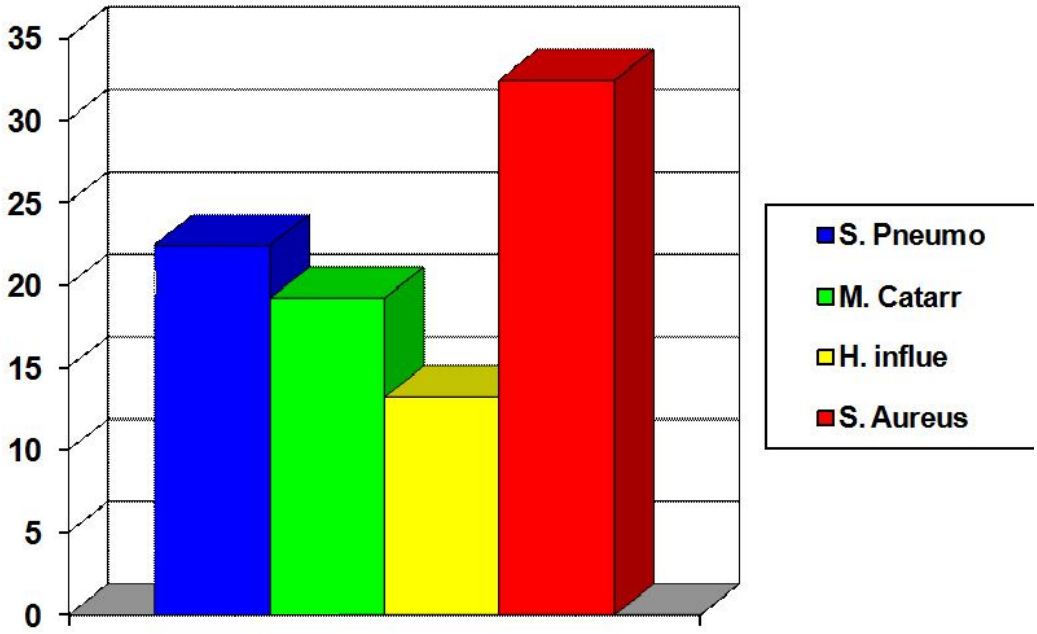


**Fig 1. Bar graft showing the percentage of patients from which the 4 most common isolates were cultured.**

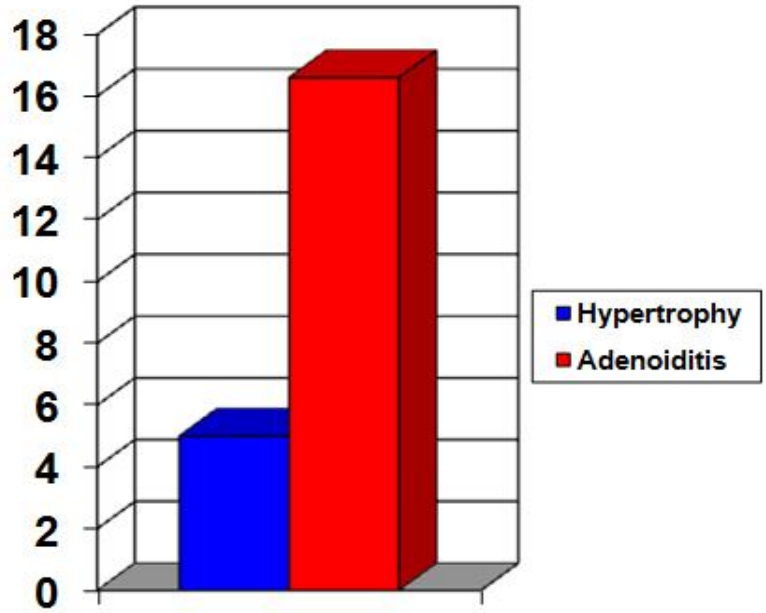


**Fig 2. Percentage of patients who grew MRSA vs diagnosis. There was a trend for higher number of MRSA in patients with chronic adenoiditis versus those with hypertrophy (16.6% vs 5%, p=0.11).**

**Table 1. Bacterial Cultures (excluding n=1 cultures).**

| Bacteriology – Aerobic (% of total) | | Bacteriology – Anaerobic/microaerophilic | |
|---|---|---|---|
| Staph aureus | 32% | Fusobacterium species | 8% |
| MRSA | 8% | Eikenella corrodens | 6% |
| Moraxella (Branhamella) catarrhalis | 19% | Prevotella melaninogenica | 5% |
| haemophilius influenzae beta lactamase neg | 13% | Micromonas (Peptostreptococcus) micros | 5% |
| Streptococcus sp. alpha-hemolyt presump not pneumococci | 14% | Anaerobic Gram-Positive Cocci | 5% |
| [S. pyogenes] Streptococcus species beta-hemolytic gp A | 13% | Streptococcus intermedius | 3% |
| Streptococcus pneumoniae penicillin-suspectible | 12% | Veillonella species | 2% |
| Staphylococcus coagulase-negative (white colony) | 8% | Gram + bacilli resembling coryneforms | 2% |
| Neisseria | 7% | Streptococcus constellatus | 1% |
| diphtheroids] Gram-positive bacilli resembling coryneforms | 7% | Prevotella oralis grp | 1% |
| Streptococcus pneumoniae penicillin-intermediate | 6% | Anaerobic coryneform gram-positive bacilli (anaerobic diphs) | 1% |
| Haemophilus parainfluenzae | 4% | | |
| Streptococcus pneumoniae penicillin-resistant | 4% | | |
| Streptococcus viridans group | 3% | | |
| [S. agalacte] Group B strep | 3% | | |
| Streptococcus species beta-hemolytic NOT grp A | 2% | | |
| Streptococcus species beta-hemolytic presumptive grp B | 1% | | |

**Table 2. Bacterial Profile by Age Group (expressed as percent of number of each age group).**

| Age (n) | MRSA | MSSA | S. pneumoniae | H. influenzae | M. catarrhalis |
|---|---|---|---|---|---|
| <2yrs (n=17) | 12% | 12% | 24% | 12% | 29% |
| 2-3yrs (n=31) | 7% | 13% | 32% | 13% | 16% |
| 4-5yrs (n=31) | 10% | 29% | 42% | 19% | 36% |
| 6-10 yrs (n=38) | 5% | 24% | 13% | 18% | 13% |
| 11-17 yrs (n = 25) | 12% | 52% | 8% | 4% | 12% |

**Table 3. Bacterial Profile by Diagnosis (expressed as percent of number of each diagnosis group).**

| Diagnosis | MRSA | MSSA | S. pneumoniae | H. influenzae | M. catarrhalis |
|---|---|---|---|---|---|
| Adenoid hypertrophy (n= 97) | 5% | 22% | 22% | 13% | 70% |
| Adenoiditis (n=54) | 13% | 30% | 24% | 13% | 19% |

**Table 4. Bacterial Profile by Comorbidity (expressed as percent of number of each comorbidity group).**

| Comorbidity | MRSA | MSSA | S. pneumoniae | H. influenzae | M. catarrhalis |
|---|---|---|---|---|---|
| None (n=73) | 8% | 21% | 25% | 11% | 19% |
| Reactive airway disease (n=17) | 12% | 24% | 18% | 18% | 29% |
| Allergies (n=6) | 33% | 33% | 33% | 17% | 33% |
| Obstructive symptoms (n=21) | 5% | 29% | 19% | 24% | 19% |
| GERD (n=4) | 0% | 75% | 0% | 25% | 0% |
| History of prematurity (n=6) | 17% | 50% | 0% | 0% | 0% |
| Cleft lip / palate (n=2) | 0% | 0% | 50% | 0% | 0% |
| History of pneumonia (n=5) | 0% | 0% | 20% | 20% | 20% |

**Table 5. Bacterial Profile by Concomitant Surgical Procedure (expressed as percent of number of each concomitant procedure group).**

| Surgical Procedure | MRSA | MSSA | S. pneumoniae | H. influenzae | M. catarrhalis |
|---|---|---|---|---|---|
| Adenoidectomy (n=20) | 10% | 25% | 10% | 15% | 15% |
| T&A (n=89) | 6% | 29% | 18% | 10% | 19% |
| Adenoid + Middle meatal antrostomy (n=9) | 0% | 22% | 11% | 33% | 22% |
| Adenoid + ventilation tubes (51) | 10% | 18% | 35% | 14% | 18% |

Qualitative and quantitative analysis of potentially pathogenic bacteria revealed no significant differences between groups (Tables 2-5) (age, diagnosis, co-morbidities, or concomitant surgical procedures), however there was a trend towards a higher number of MRSA in patients with chronic adenoiditis versus those with adenoid hypertrophy ((17% vs 5%, p=0.11), see Fig. 3).

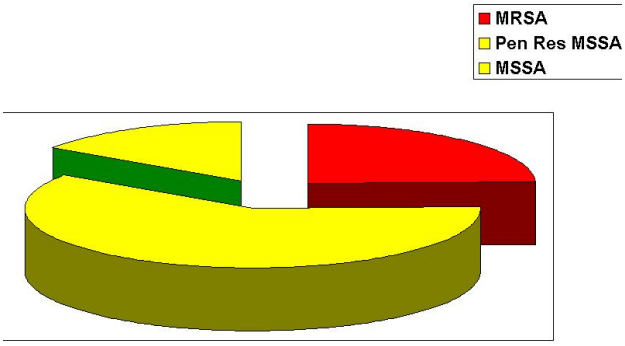


**Fig 3. Percentage of S. aureus isolates who were penicillin resistant, methicillin-resistant (MRSA) or methicillin-sensitive.**

## DISCUSSION

Knowledge of common bacteria prevalence and resistance patterns guides antimicrobial therapy. Multiple previous studies on adenoid microbiology have found that S. pneumoniae, M.catarrhalis, and H. influenzae are the most common organisms cultured from diseased adenoid tissue, and antibiotic treatment has been dictated with this knowledge.[1-4] Around the year 2000 there developed a perceived increase nationally in rise of infections caused by community-acquired MRSA. Multiple studies analyzing nasopharyngeal bacterial colonization were produced around this time. In a study published by Brook et al in 2000 adenoid cultures of 60 children, S. aureus ranked 5th overall in prevalence, being present in 33.3% of cultures.[5] In 2001, Nakamura et al conducted a nasal colonization study of healthy children and discovered that 29% (145 of 500) cultured S. aureus, with 0.8% (4 of 500) being colonized with MRSA.[6] Cheng-Immergluck et al reported that of 291 children seeking routine well-child care, 54 (18.6%) were colonized with S. aureus, with a 1.7% MRSA colonization rate.[7] Also in 2001, Hussain et al reported that out of 500 healthy children attending an outpatient clinic, 122 (24.4%) children were colonized with S. aureus, and 3 (2.5%) of these isolates were MRSA.[8]

Since that time, there has continued to be an increase in the number of community-acquired MRSA infections,[9] and more recent studies of nasopharyngeal microbiological colonization have documented a rise in carrier rates of S. aureus. Although Gorwitz et al found a prevalence of colonization with S. aureus to have decreased from 32.4% to 28.6% between the study periods 2001-2002 to 2003-2004, the prevalence of colonization with MRSA was seen to have increased from 0.8% to 1.5% between the same study periods.[10] In a 2005 study of 500 children presenting for health maintenance visits, Creech et al showed the prevalence of S. aureus colonization by nasal swabs to be about 36.4%, with 9.2% children being colonized with MRSA. Erythromycin resistance was present in 54% of isolates, and clindamycin resistance was present in 26%.[11] In 2007 Emaneini et al demonstrated S. aureus was found in the adenoid tissue in 23% of patients with adenoid hypertrophy undergoing adenoidectomy.[12] In 2011 Elwany et al found S. aureus to be present in 22.3% of specimens, although the presence of MRSA was not reported from this group.[13]

Conversely, other recent studies have reported nasopharyngeal colonization profiles more in line with traditional studies. In 2005, a study by Brook et al of 72 nasopharyngeal cultures of children who presented with acute otitis media or otitis media that recurred after amoxicillin therapy was consistent with traditional bacteriological profiles, and found children harbored strep penumo (61.9%), H. influenzae (30.6%), M. catarrhalis (18.1%), and less-frequently S. aureus (12.5%).[14] In 2010

Fekete-Szabo et al reported prevalence of S. pneumoniae, H. influenzae, M. catarrhalis, and S. aureus culture rates of 75%, 50%, 20%, and 15% respectively, although the sample size was smaller, at only 20 patients.[15] In 2011, Marzouk, et al reported culture results from nasopharyngeal swabs in 76 children undergoing bilateral myringotomy and tube insertion with or without adenoidectomy for chronic otitis media with effusion or recurrent acute otitis media. In their study two nasopharyngeal cultures were positive for MSSA (2.63%), and 2 were positive for MRSA (2.63%), however further bacterial profiles were not listed for the nasopharyngeal cultures.[16]

Our study found the second highest S. aureus and MRSA colonization rates reported thus far, and confirms the findings of the larger more recent studies that have documented S. aureus colonization rates to have dramatically increased over the past decade. With the rising importance of S. aureus, particularly methicillin resistant isolates, in infectious diseases of the head and neck, nasopharyngeal colonization profiles need to be more accurately assessed. The anterior nasal cavities are the primary reservoir of S. aureus in adults and children, with approximately 30% of the general population being colonized, and 1.5-3% being persistently colonized with MRSA. Nasal carriage has been shown to be associated with an increased risk of S. aureus infections in various patient populations.

Previous studies of resistance patterns in adenoid microbiology have shown that only 33% of S. aureus isolates were penicillin or methicillin resistant, in contrast to recent studies that have reported penicillin resistance rates for community-acquired isolates of up to 90% in other body sites.[17] In our study, 84% of S. aureus isolates were either penicillin or methicillin resistant. Our study numbers are therefore alarming but not altogether unanticipated.

Although our patient population was undergoing "routine" surgery, they do represent a tertiary referral center population and, as such, they may harbor a higher percentage of resistant organisms than a community-based practice might encounter. One original intension of our study was to quantify the presence of eosinophils and neutrophils in tissue specimens. Pathology results from cell counts were widely disparate between specimens and as a result this was abandoned early in the study.

Correlating cell counts to bacteriology and diagnosis (chronic adenoiditis vs. adenoid hypertrophy) could represent an area for further research.

Of the above studies, when separating them based on use of core tissue or swabs for diagnosis, there was little overall difference in prevalence of S. aureus. The above studies reporting MRSA presence used swabs for obtaining cultures, and consequently our results may reflect a more accurate prevalence of this organism. It has been well established that core adenoid tissue represents a more reliable means of sampling Waldeyer's ring bacteriology, with surface cultures having been shown to have limited usefulness in accurately determining the bacteriologic makeup in core adenotonsillectomy specimens.[18-20] To our knowledge, no studies to date using core adenoid samples have reported MRSA, and consequently our results are important towards establishing the current prevalence of this organism.

Given that amoxicillin is currently the first-line treatment for many conditions tied directly to adenoid microbiology, the results of this study suggest that this particular antibiotic may often be inadequate to treat the most common bacteria cultured from our patients. Therefore the bacteria and resistance patterns of diseased adenoid tissue should be revisited with particular attention to the expanding role of resistant strains of S. aureus, with antibiotic coverage selected judiciously in light of this apparent shift in microbiologic spectrum. Further analysis of the role of adenoidectomy on changing nasopharyngeal microbiology should also be investigated

## CONCLUSION

Both the recent rise of community-acquired MRSA and the expanding role of resistant strains of S. aureus are reflected in this contemporary analysis of core adenoid tissue specimens. Knowledge of common bacteria and resistance patterns guides antimicrobial therapy, and consequently, the use of amoxicillin as the current first-line treatment for many conditions tied directly to adenoid microbiology may need to be revisited.

## REFERENCES

1. DeDio RM, Tom LW, McGowan KL, et al. Microbiology of the tonsils and adenoids in a pediatric population. Arch Otolaryngol Head Neck Surg. 1988;114:763-5.

2. Pillsbury HC 3rd, Kveton JF, Sasaki CT, et al. Quantitative bacteriology in adenoid tissue. Otolaryngol Head Neck Surg. 1981;89:355-63.

3. Fukuda K, Matsune S, Ushikai M, et al. A study of the relationship between adenoid vegetation and rhinosinusitis. Am J Otolaryngol. 1989;10:214–16.

4. Tomonaga K, Kurono Y, Chaen T, et al. Adenoids and otitis media with effusion: nasopharyngeal flora. Am J Otolaryngol. 1989;10:204-7.

5. Brook I, Shah K, and Jackson W. Microbiology of Healthy and Diseased Adenoids. Laryngoscope. 2000;110:994–99.

6. Nakamura MM, Rohling KL, Shashaty M, Lu H, Tang YW, Edwards KM. Prevalence of methicillin-resistant Staphylococcus aureus nasal carriage in the community pediatric population. Pediatr Infect Dis J. 2002;21:917–22.

7. Cheng Immergluck L, Kanungo S, Schwartz A, McIntyre A, Schreckenberger PC, Diaz PS. Prevalence of Streptococcus pneumoniae and Staphylococcus aureus nasopharyngeal colonization in healthy children in the United States. Epidemiol Infect. 2004;132:159–66.

8. Hussain FM, Boyle-Vavra S, Daum RS. Community-acquired methicillin-resistant Staphylococcus aureus colonization in healthy children attending an outpatient pediatric clinic. Pediatr Infect Dis J. 2001;20:763–7.

9. Naseri I, Jerris RC, and Sobol S. Nationwide trends in pediatric Staphylococcus aureus head and neck infections. Arch Otolaryngol Head Neck Surg. 2009;135:14-16.

10. Gorwitz RJ, Kruszon-Moran D, McAllister SK; et al. Changes in the prevalence of nasal colonization with Staphylococcus aureus in the United States, 2001-2004. J Infect Dis. 2008;197:1226-34.

11. Creech CB II, Kernodle DS, Alsentzer A, Wilson C, Edwards KM. Increasing rates of nasal carriage of methicillin-resistant Staphylococcus aureus in healthy children. Pediatr Infect Dis J. 2005;24:617-21.

12. Emaneini M. Molecular characterization of Staphylococcus aureus isolated from children with adenoid hypertrophy: emergence of new spa types t7685 and t7692. Int J Pediatr Otorhinolaryngol. 2011;75:1446-9.

13. Elwany S. Relationship between bacteriology of the adenoid core and middle meatus in children with sinusitis. J Laryngol Otol. 2011;125:279-81.

14. Brook I and Gober A. Antimicrobial resistance in the nasopharyngeal flora of children with acute otitis media and otitis media recurring after amoxicillin therapy. J Med Microbiol. 2005;54:83–5.

15. Fekete-Szabo G, Berenyi I, Gabriella K, Urban E, Nagy E. Aerobic and anaerobic bacteriology of chronic adenoid disease in children. Int J Pediatr Otorhinolaryngol. 2010;74:1217–20.

16. Marzouk HA, Nathawad R, Hammerschlag MR, Weedon J, Bachman D, Goldstein NA. Methicillin-Resistant Staphylococcus aureus Colonization in Otitis-Prone Children. Arch Otolaryngol Head Neck Surg. 2011;137:1217-22.

17. Ammerlaan HS, Kluytmans JA, Berkhout H, Buiting A, de Brauwer EI, van den Broek PJ, et. al. Eradication of carriage with methicillin-resistant Staphylococcus aureus: effectiveness of a national guideline. J Antimicrob Chemother. 2011;66:2409-17.

18. Timon CI, Cafferkey M, Walsh M. Infection of Waldeyer's ring: value of pernasal retropharyngeal swabs. J Otolaryngol. 1991;20:279-82.

19. Gaffney RJ, Timon CI, Freeman DF, Walsh MA, Cafferkey MT. Bacteriology of tonsil and adenoid and sampling techniques of adenoidal bacteriology. Respir Med. 1993;87:303-8.

20. Gul M, Okur E, Ciragil P, Yildirim I, Aral M, Akif Kilic M. The comparison of tonsillar surface and core cultures in recurrent tonsillitis. Am J Otolaryngol. 2007;28:173-6.