Differences in Clinical Presentation of Neck Abscesses Between Infants and Children

Neha Kumar, Marc Gelpi and Jay Shah

1. Introduction

Neck abscesses are collections of pus that can be located in either a superficial layer of the neck, or deep layer of the neck; however, the latter is more commonly reported in the literature than the former.

Deep neck infections are those that include the cervical fascia, both superficial and deep, and retropharyngeal, parapharyngeal, and peritonsillar spaces.[1] The retropharyngeal space is a potential space anterior to the prevertebral fascia that extends from the skull base to the bifurcation of the trachea in the mediastinum, serving as a potential pathway to the chest.[2] The parapharyngeal abscess is located posterior to the infratemporal fossa anteriorly, nasopharynx, and the lateral pharyngeal wall medially, vertebral column posteriorly, and mandibular ramus laterally.[3] Finally, the peritonsillar abscess, consisting of loose areolar tissue overlying the tonsil, is bounded by the superior pharyngeal constrictor muscle and the anterior and posterior tonsillar pillars.[4]

In adults, deep neck abscesses are usually caused by direct infection resulting from the presence of a foreign body, or from some kind of penetrating injury to the posterior pharyngeal wall while in children, they are commonly caused by suppuration of the retropharyngeal lymph nodes, which drain from the nasopharynx, oropharynx, and tonsils.[5] In children, most cases follow an upper respiratory tract infection such as tonsillitis, adenitis, dental infection, pharyngitis, and lymphadenitis, and possibly represent spread of infection from contiguous areas.[1,2] Other less frequent causes include penetrating trauma, vertebral osteomyelitis, parotitis, mastoiditis, and sinusitis.

Reports in the literature show a decreasing incidence of deep neck abscesses with increasing age in children.[6] In fact, they are more frequent in children under the age of 5 years than in the rest of the pediatric population.[7,8,9,10,11,12] The reason for this is thought to be due to the increased number of lymph nodes that run in a paramedian chain in the retropharyngeal space in children under the age of 5, and spontaneously regress after that.[9,13] Where these neck masses occur in children may vary based on age; for example, one study found that retropharyngeal abscesses were more likely to occur in those aged less than 10 years while peritonsillar abscesses were more likely to occur in those aged 10-18 years.[14]

Studies have found deep neck abscesses in the pediatric population are found to be polymicrobial.[15,16] The predominant organism varies between studies, though the most common in mucus membranes are reported to be anaerobic bacteria; in particular, anaerobic gram-negative bacilli.[17,18] The most common

aerobes are generally reported to be streptococci and staphylococci.[19,20,21] Recent research reports the rise of methicillin-resistant *Staphylococcus aureus* (MRSA) infected deep neck abscesses in the pediatric population, particularly over the past few decades.[22,23,24,25]

Furthermore, the rising incidence of MRSA in pediatric neck abscesses has been linked to increasing morbidity, particularly in children with immunosuppressive conditions such as cancer.[26] This is important to note as this increase in MRSA colonization presents a challenge in determining the correct choice of an empiric antibiotic. Research also shows that MRSA colonization is linked to nearly double or triple the length of hospital stay compared to colonization by any other organism in the adult population.[27,28] However, there have been no similar reports comparing hospital stay duration and MRSA infection versus colonization by other organisms in the pediatric population. Finally, we decided to study C-Reactive Protein (CRP) levels as studies show that normalization of CRP levels can be considered as a criterion for the discontinuation of antibiotic therapy to minimize antibiotic exposure and shorten hospital stay duration.[29] Therefore, we find it important to determine which members of the pediatric population are most at risk for MRSA infection, whether MRSA colonization affects hospital stay duration in either subset of the pediatric population, and whether there is a difference in CRP levels between populations or if a link exists between CRP level and MRSA colonization.

Overall, the incidence of neck abscesses in the pediatric population has been increasing over the past few decades.[1,12,30,31,32,33,34,35] The reasons for the increased incidence have been speculated at, but have not been fully elucidated as of the present. Despite this, little research has been done to characterize the differences in presentation of neck abscesses in subsets of the pediatric population, namely, between infants (0-1 years of age) and children from 1-17. There are a few studies that note differences in abscess location and microbiology of the infected areas between infants and older children.[34,36] However, no studies, as far as we know, examine differences in clinical presentation, including abscess location, microbial colonization, duration of hospital stay, and C-reactive protein (CRP) levels between these two groups. Given the increasing incidence of neck abscesses in the pediatric population, we recognize the importance of covering this gap in the literature. Our study aims to accomplish this by comparing a population of infants 0-1 years of age to children 1-18 in terms of the aforementioned factors.

2. Material and Methods

2.1. Subjects

After receiving approval from the Institutional Review Board at the University Hospitals Case Medical Center, a retrospective chart review was performed. Inclusion criteria were patients 18 years of age or younger, who were diagnosed with a neck abscess and were treated with incision and drainage between January 1st, 2004, to December 1st, 2014. The diagnosis of neck abscess was defined by the operating room finding of pus during incision and draining. We also chose patients who presented with no other medical conditions that could potentially confound results. Current Protocol Terminology and International Classification of Diseases codes were used to identify cases from our clinical database. Medical records

were reviewed to obtain patient age, sex, laboratory data including inflammatory markers and microbiology cultures and sensitivity, and hospital stay duration. Radiographic reports and surgical logs were examined for abscess size and location (classified as either deep or superficial, with deep neck abscesses divided into cervical, parapharyngeal, retropharyngeal, peritonsillar, submandibular, occipital, submental, post auricular, lymph node, parotid, and carotid space). Patients with facial abscesses and thyroid gland infections were excluded.

In total, we reviewed and included the charts of 248 patients (73 infants, 175 non-infants). The number of patients in different analyses was variable because of incomplete data.

2.2 Statistics

Statistical analyses were performed using the Statistical Package of Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Comparisons between groups were made using Wilcoxon signed-rank t-test, 2 independent samples t-test, and the chi-square test when appropriate to calculate the statistical differences between patient baseline characteristics of both groups. Significance for differences was expressed using p values. A two-tailed p value of <0.05 was considered significant.

3. Results

3.1. Patient characteristics and Abscess Location (see **Table 1***)*

Table 1. Patient characteristics and abscess location.

	Infants	Non-Infants	Combined Total
Gender, n%	73 (100%)	175 (100%)	248 (100%)
Male	34 (46.575%)	104 (59.429%)	137 (55.645%)
Female	39 (53.425%)	71 (40.571%)	110 (44.355%)
Mean Age	8.205 months		
Abscess Location, n%	73 (100%)	175 (100%)	248 (100%)
Superficial	5 (6.85%)	1 (0.57%)	
Deep	68 (93.15%)	174 (99.43%)	
Cervical	49 (67.12%)	80 (45.71%)	
Submandibular	6 (8.22%)	9 (5.14%)	
Retropharyngeal	5 (6.85%)	19 (10.86%)	
Parapharyngeal	4 (5.48%)	33 (18.86%)	
Occipital	2 (2.74%)	0	
Submental	2 (2.74%)	10 (5.71%)	
Parotid	2 (2.74%)	0	
Lymph node	1 (1.37%)	0	
Carotid Space	1 (1.37%)	0	
Post auricular	1 (1.37%)	0	

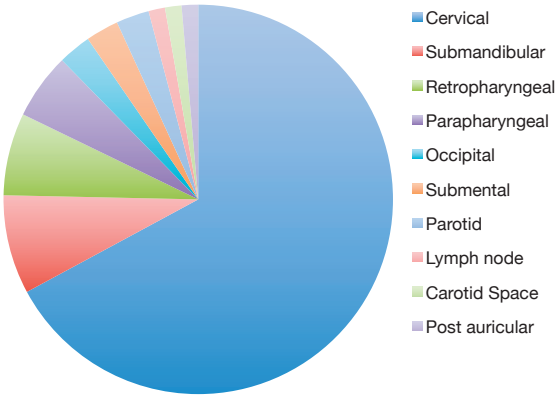

Chart 1. Distribution of deep neck abscesses in infants.

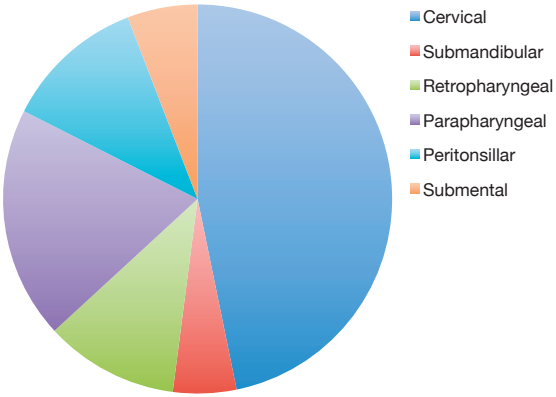

Chart 2. Distribution of deep neck abscesses in non-infants.

Out of the 248 patients studied, 73 were infants and 175 were non-infants. The mean age of infants was 8.205 months. All patients received surgical treatment for their abscess.

Both populations presented most frequently with deep neck abscesses as opposed to superficial neck abscesses. 174 out of 175 non-infants (99.43%) and 68 out of 73 infants (93.15%) presented with deep neck abscesses.

Infants (see **Chart 1**) presented most commonly with cervical neck abscesses (67.12%) followed by submandibular (8.22%), retropharyngeal (6.85%), and parapharyngeal abscesses (5.48%). Non-infants (see **Chart 2**) presented most commonly with cervical neck abscesses (45.71%), followed by parapharyngeal (18.86%), peritonsillar (11.43%), and retropharyngeal abscesses (10.86%). Though both groups presented most commonly with cervical neck abscesses, infants are statistically significantly more likely to present with cervical neck abscesses than non-infants (p-value=0.0021).

Furthermore, infants presented in more locations overall than non-infants (10 locations versus 6 locations); however, the vast majority of infants presented as cervical neck abscesses. On the other hand, non-infants, while presenting most commonly with cervical neck abscesses, also had a significant portion of the population presenting with parapharyngeal, peritonsillar, and retropharyngeal abscesses.

3.2. MRSA Colonization (see **Table 2***)*

48.64% of infants presented with MRSA colonization compared to 13.74% of non-infants as seen in **Chart 3**. A chi-square test was performed and determined a z-value of 5.9 corresponding to a p-value of <0.0001 indicating statistical difference between the two groups.

Table 2. Infants with MRSA colonization compared to non-infants

	Infants	Non-Infants	Difference
Sample Proportion	0.4864	0.1374	0.349
95% CI (asymptomatic)	0.3717-0.6011	0.0864-0.1884	0.2323-0.4657
z-value	5.9		
p-value	<0.0001		Significant

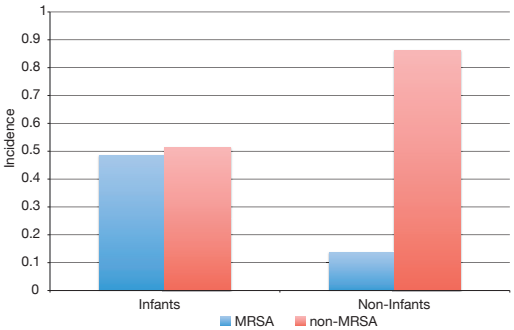

Chart 3. MRSA vs non-MRSA microbial colonization in infants vs non-infants

3.3 CRP-levels (see **Table 3***)*

CRP-levels were obtained from 56 infants and 115 non-infants. A two-tailed t-test of two independent means determined a *p*-value of 0.8734, which corresponds to a non-significant difference between the two means. A Wilcoxon signed rank-sum test was also performed to determine correlation between MRSA colonization and CRP levels in both infants and non-infants. In infants, statistical analysis determined a *p*-value of 0.5487, corresponding to a non-significant statistical difference. In non-infants, statistical analysis determined a *p*-value of 0.7228 corresponding to a non-significant statistical difference. A visual representation of these statistics is seen in **Chart 4**.

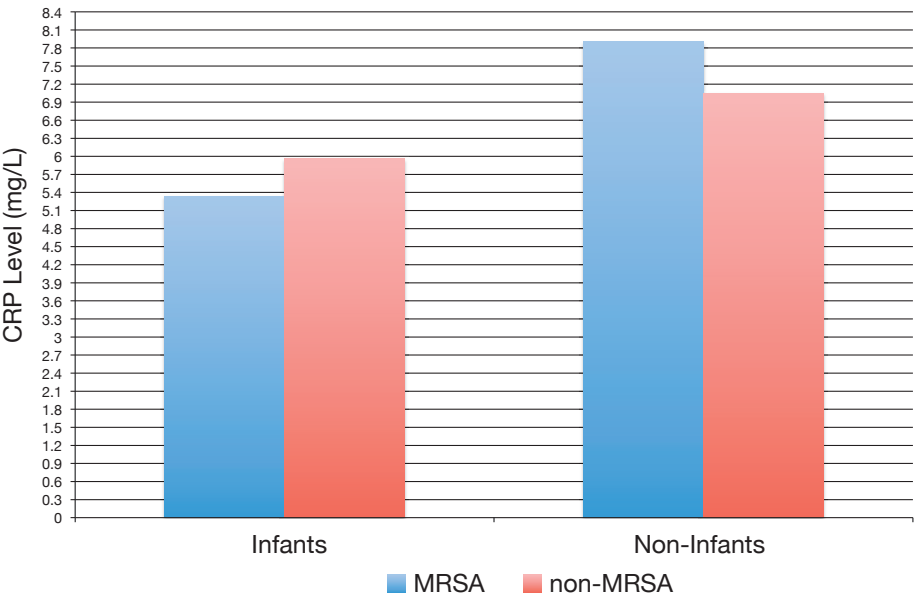

Chart 4. CRP levels & microbial colonization in infants vs non-infants

Table 3. CRP-levels were obtained from 56 infants and 115 non-infants.

	Infants	Non-Infants	Statistical analysis	*p* value	Statistical difference
Mean	7.3307	7.1723			
Variance	37.023	37.1825			
Std. Deviation	6.0847	6.0977			
N	56	115	*p* (2-tailed)	0.8734	Insignificant
Correlation Between MRSA Colonization & CRP levels in Infants					
	MRSA	non-MRSA	Statistical analysis	*p* value	Statistical difference
Mean	5.3338889	5.9567568			
Std Deviation	6.2318818	6.1656333			
N	36	37			
			p-value	0.5487	Insignificant
Correlation Between MRSA Colonization & CRP levels in Children					
	MRSA	non-MRSA	Statistical analysis	*p* value	Statistical difference
Mean	7.9052941	7.045102			
Std Deviation	7.6491773	5.8255803			
N	17	98			
			p-value	0.7228	Insignificant

3.4 Hospital Stay Duration (see **Table 4***)*

Hospital stay duration values were obtained from 68 infants and 165 non-infants. A two-tailed t-test of 2 independent means was performed to determine t=3.7579 corresponding to a *p*-value of 0.0002 indicating statistical significance between the groups. A test to determine correlation between MRSA infection and duration of hospital stay was performed in both infants and children. In infants, statistical significance was seen with a *p*-value of 0.0037. However, no statistical significance was seen in non-infants, with a p-value of 0.2186. A visual representation of these statistics is seen in **Chart 5**.

4. Discussion

The aim of this study was to determine whether there were differences in presentation of neck abscess between infants (<1 year) and non-infants (1-18) in terms of location of neck abscess (superficial versus deep), microbial colonization of abscess (MRSA versus non-MRSA colonization), CRP-level at initial presentation of abscess, and hospital stay duration. We also wanted to determine whether there was a correlation between microbial colonization and CRP-level and microbial colonization and hospital stay duration in either the infant or non-infant group, or both.

Table 4. Hospital stay duration values were obtained from 68 infants and 165 non-infants.

Difference Between Hospital Stay Duration Between Infants/Non-Infants					
	Infants	Non-Infants	Statistical analysis	*p* value	Statistical difference
Mean	6.2353	3.903			
Variance	52.9289	4.5027			
Std. Deviation	7.2752	2.122			
n	68	165	*p*-value (2-tailed)	0.0002	Significant
Correlation Between MRSA Infection & Duration of Stay In Hospital in Infants					
	MRSA	non-MRSA	Statistical analysis	*p* value	Statistical difference
Mean	4.973	3.6176			
Variance	4.6381	2.4857			
Std. Deviation	2.1536	1.5766			
n	37	34	*p*-value (2-tailed)	0.0037	Significant
Correlation Between MRSA Infection & Duration of Stay in Hospital in Non-Infants					
	MRSA	non-MRSA	Statistical analysis	*p* value	Statistical difference
Mean	4.4348	3.8417			
Variance	2.0751	4.9458			
Std. Deviation	1.4405	2.2239			
n	23	139	*p*-value (2-tailed)	0.2186	Insignificant

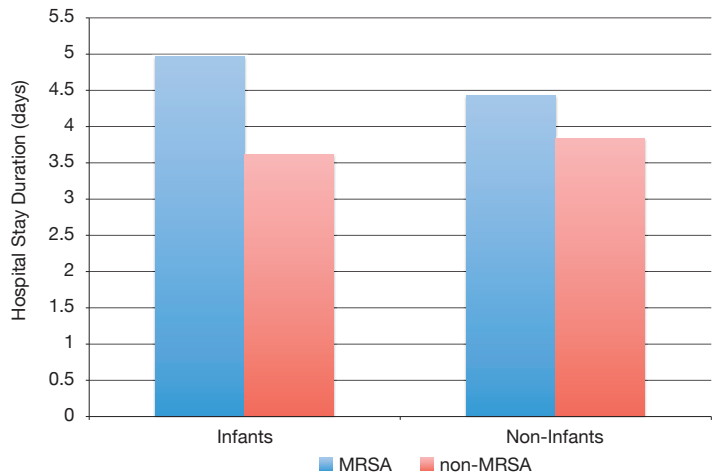

Chart 5. Hospital stay duration & microbial colonization in infants vs non-infants

Our findings show a higher incidence of deep neck abscess as opposed to superficial neck abscesses in both populations. Given that most studies in the literature of neck abscesses focus on deep neck abscesses, it is likely that deep neck abscesses are either of a greater clinical significance or have a higher incidence than superficial neck abscesses. The literature does not include any information on the incidence of cervical neck abscesses in subsets of the pediatric population; however, peritonsillar abscesses were the second most common deep neck abscess in non-infants and presented at a higher rate compared to in infants. These results are supported by the literature.[15,37] However, our study differed from the literature in that non-infants, and not infants, reported most frequently with retropharyngeal abscesses—in the literature, it is more commonly younger children presenting with this type of neck abscess.[15]

Our findings on microbial colonization are in line with earlier studies, which state an increased incidence of MRSA in infants compared to other members of the pediatric population.[38] Several studies have identified risk factors that predispose certain infants to acquiring MRSA; some of those factors have included low birth weight, prematurity, younger gestational age, feeding methods, and procedures that neonates may require including surgery, endotracheal tube intubation, and mechanical ventilation.[39,40,41] The reasons for the higher incidence of MRSA colonization in infants could be attributed to several factors. One potential theory is that most humans (30-70%) are carriers of *S. aureus*, so neonates have a high likelihood of contracting the bacteria immediately after birth.[39] Other reasons could include vertical transmission from mothers to infants, such as through breast-feeding.[42,43]

CRP levels are normally between 1.0 to 3.0 mg/l; CRP elevation is part of the acute phase response to acute and chronic inflammation that can be caused by bacterial infection.[44] Given that MRSA infections compared to infection by other organisms are associated with higher morbidity and mortality and an increased rate of surgical site infections, we had expected to see a higher CRP level in MRSA infections.[45] However, that was not the case. Although we found there to be no correlation between CRP level and MRSA colonization in either group, we would recommend future studies study this link. This link may have particular significance in the infant population as studies have shown that CRP levels can be used as a parameter to guide duration of antibiotic treatment in infants with bacterial infection, and also as an early diagnostic indicator of bacterial infection in premature newborns.[46,47] Given our small sample size, it is important to continue studying this link as C-reactive protein levels correlate with clinical response to therapy and may be used to monitor treatment; therefore, if there is a link between MRSA and CRP levels, it may have an impact on future treatment.[48] To our knowledge, we were unable to find any other studies that specifically studied differing CRP levels between infants and other members of the pediatric population. Our results did not show a significant difference between CRP levels in the groups; however, given the dearth of information in the literature, we would suggest observing CRP level differences between infants and non-infants on a larger scale.

What is particularly interesting is the fact that a correlation was seen between MRSA colonization and longer hospital stay duration in infants, which supports the literature, as studies of older patients show that MRSA colonization was associated with longer durations of stay.[49,50] Given that methicillin-resistant strains cause treatment to become less effective, predispose one to MRSA infection during the same hospitalization, and are more likely to cause subsequent hospital infections, it makes sense for this correlation to be seen.[51] Interestingly, however, no such correlation was found in non-infants, which differs from the results of the aforementioned studies.

This retrospective longitudinal study was only performed at a single center; thereby, results may not be generalizable to the whole population. Secondly, it should be noted that only a few characteristics were studied for differences between groups—several others factors could be relevant in terms of distinguishing between clinical presentation of neck abscess between infants and children. These factors could include imaging results and results of blood tests.

Hopefully these findings will help to implement specific treatment guidelines for infants with neck abscesses, because this vulnerable group of children is more prone to longer hospital stays and a higher risk of MRSA colonization than non-infants.

5. Conclusions

Neck abscesses are frequent in the pediatric population, and their incidence is increasing. Based on the differing clinical presentations of neck abscesses in infants and non-infants, treatment between the two groups may vary in terms of antibiotic therapy and surgical intervention. Further characterization of these groups is desirable, and more research should be done on this topic.

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