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Antibacterial Sensitivity of Bacterial Flora of Lower Respiratory Tract After a Week of Tracheostomy

KEYWORDS: Tracheostomy, bacterial flora, lower respiratory tract, gram negative bacteria, Pseudomonas aeruginosa, Klebsiellapneumoniae, Acenitobacterspps.

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ABSTRACT *Objective: To evaluate the bacteriology of lower respiratory tract (LRT) and antimicrobial sensitivity following a week tracheostomy*

Materials and Methods: 70 patients who underwent tracheostomy for various indications from June 2013 to December 2014 were included in this time based study. Tracheal secretions were taken in all the cases and sent for culture and sensitivity. Specimens for culture and sensitivity were collected using a catheter which passes through the tracheostomy tube into the trachea and were analyzed at a single microbiological laboratory. Microbes were identified by their colonial morphology and characteristic biochemical tests

Results: Out of 70 patients 56 patients (80%) had shown growth during the culture;Gram Negative Bacilli (AGNB), particularly Pseudomonas aeruginosa (48.6%) and Klebsiellapneumoniae(15.7%), Acenitobacter spp. in 6 patients while Methicillin Resistant Staphylococcus aureus (MRSA) was seen in 1 patient. About half of the pseudomonas was found to be resistant to cephalosporinsandmajority showing sensitivity to carbapenems and gentamicin. Acenitobacterwas found to be more sensitive to higher antibiotics like piperacilin-tazobactam and carbapenems only.

Conclusion: GNB were the predominant isolates of LRT infections withPseudomonas aeruginosa andKlebsiellapneumoniae and as the commonest isolates. Patients with tracheostomy on prior injudicious antimicrobial therapy are at high risk for contracting lower respiratory tract infections due to resistant GNB.

INTRODUCTION

Tracheostomy is used to describe the creation of an opening on the skin surface which leads into the trachea playing a pivotal role in airway management[1]. Being a surgical procedure, it is not without complications. Post-tracheostomy lower respiratory tract infection is not an uncommon complication in the current era[2]. The normal trachea is protected from bacterial colonization by natural barriers. These are partially bypassed following tracheostomy and direct exposure of the lower airways to the pathogens may occur[3]. Tracheo-bronchitis is common in patients with tracheostomy rates of upto 60% have been reported in somestudies[4,5]. In this era of injudicious use of antibiotics, resistance to commonly used antibiotics are wide spread. The purpose of this study is to understand the nature of bacterial flora of the lower airways in patients with short term tracheostomy and their antibiotic sensitivity patterns.

MATERIALS AND METHODS

Written informed consents were obtained from all patients or their first degree relatives before the study. Our study, approved by institutional ethics committee is a descriptive time based study of 18 months duration from June 2013 – December 2014. All patients in whom tracheostomy was performed during the time period were included in the study. Patients who were changed to metal tracheostomy tube during the first tube change within one week of procedure were excluded from the study because the sterility of the metal tube could not be confirmed. Also patients who were discharged from hospital within one week of the procedure and those who expired during the period was excluded. Thus after applying the exclusion criteria, 70 patients (59 males and 11 female subjects) were finally included in the study. The patients were selected consecutively and were included once the inclusion criteria was met.All the patients were on antibiotic therapy (Injection cefotaxime 1gm X twice daily) while taking the culture and sensitivity sample. Data including nature of bacteria grown and antibiotic sensitivity of these bacteriae was noted.

In all patients included in the study, after a week of tracheostomy, a sterile suction catheter was introduced into the trachea and tracheal suctioning was done to clear the secretions. Using aseptic precautions, the tip of the suction catheter was cut and placed in a sterile container. The container which was sealed and transported to the microbiology lab for bacteriological analysis. Bacterial Cultures were done on McConkeys agar, Chocolate agar and Sheep Blood agar and the isolates were identified using grams staining and standard biochemical reactions.

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD and results on categorical measurements are presented in Number (%).

RESULTS

Total of 70 patients were included in the study who under-

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went tracheostomy during the study period. Mean age of the patients studied was 57.2 years with age range from 28-61 years. This included 59 males and 11 females.

i. Tracheal aspirate culture

56 out of 70 (80%) tracheal suction catheter tip cultures yielded a positive result. With respect to the identity of the bacteriae studied in these positive cultures, majority were gram negative bacilli (n=53) with 34 (47.7%) samples growing *Pseudomonas aeruginosa* followed by *Klebsiellapneumoniae*in 11 samples (18.5%) Other organisms noted were *Acenitobacterspps* (7.7%, n=6), *Enterobacterspps* (1.8%, n=1), *Citrobacterspps* **(Table 1).** 14 samples failed to grow any bacteria even after a week of tracheostomy. Gram positive bacteria,*Staphylococcus aureus* was noted in 3 samples (11.5%).

ii. Antibiotic sensitivity

Antibiotic sensitivity pattern of each organism studied were noted. Highest mean resistance among gram negative bacteria was noted to cefotaxime (n=33, 62.2%) followed by ciprofloxacin (60.3%) and ceftazidime (49%) **(Table 2).** Lowest resistance among gram negative bacteria was to meropenem (1.8%) and imipenem (5.6%). *Pseudomonas aeruginosa* showed highest resistance to cefotaxime, ciprofloxacin and ceftazidime and less resistance to carbapenems, piperacillintazobactam and combination of cefoperazone and sulbactam. Similarly *Klebsiellapneumoniae*showed highest resistance again to cephalosporins and ciprofloxacin with good sensitivity towards higher antibiotics. *Acinetobacter*spps. was resistant to almost all routinely used antibiotic showing only good sensitivity towards carbepenems. Our study hadone sample positive for MRSA which was sensitive to vancomycin and linezolid.

DISCUSSION

The normal trachea is protected from bacterial colonization, and in healthy individuals trachea is considered sterile with no bacterial colonisation[6]. Tracheostomy, bypassing the natural barriers, eliminates the filtering mechanisms of the upper airways, reduces the effectiveness of the cough reflex, and interferes with glottic closure which may all contribute to bacterial colonisation in these patients.

This study is a qualitative assessment of the tracheal flora and its antibiotic sensitivity patterns in patients with short term tracheostomies. The present study demonstrates that tracheostomy is independently associated with lower respiratory colonization which subsequently progresses to lower respiratory tract infection.

Some of the patients in our study were, during the first one week period were partly cared for in the Intensive care unit (ICU) owing to their serious illnesses. Thus, it's noteworthy that an external intervention like endotracheal intubation into the airways of these patients may have led to bacterial colonization. It is significant that most of these patient showed positive bacterial within a week of tracheostomy and even after being on higher antibiotics like Carbapenems. *Acenitobacterspps* and *Klebsiellapneumoniae* are widely regarded as hospital acquired bacteria[7]. Endotracheal intubation predisposes to infections by causing direct effects on airways, reduction of local host defenses, reducing muco-ciliary function, causing stagnation of mucus and increase in entrance of bacteria[8] predisposing to colonisation by these 'hospital acquired bacteriae'. This observation suggests that despite the adherence of strict aseptic precautions, constant exposure to the organisms in the hospital environment, results in exogenous acquisition and colonization of the lower airways. Also worrisome is that in our study majority of the bacteria, especially *Acenitobacterspps* was found to be resistant to almost all antibiotics except carbapenems. A similar picture was noted in previous studies by Jung et al[9] and ShanthiM et al[10]. It has also to be added that due to the fact that most of these patients were on antibiotics might have led to development of multi-resistant forms of bacteria, which may partly explain the reason for chances of persistence of colonization in the future in these patients. Although strict aseptic precautions are followed, it is without doubt that continued presence of bacteria in the hospital environment does lead to persistent infection.

The data in the current study provides further evidence of airway colonization with potentially pathogenic bacteria post-tracheostomy. Our study noted Gram Negative Bacteria (GNB) were cultured more frequently in the samples studied. *Pseudomonas aeruginosa* being the most commonly isolated bacteria. Many other similar studies on tracheostomy have shown that GNB are the most common pathogens causing nosocomial pneumonia[11,12,13]. In a recent study by Pignattiet al[14], in the microbiological analysis performed on tracheal aspirates, *Pseudomonas aeruginosa* was most commonly identified. Guimbellotet al[15] similarly noted increased development of gram negative bacterial infection in children undergoing tracheostomy. Sakurai et al[16] studied 15 patients with long term tracheostomies and noted persistent colonization with *Pseudomonas* in them. Our study was in contrast to a recent study done by Abdollahiet al[17], in that majority of the bacteria grown was of *Acenitobacterspps* (24%) followed by *Pseudomonas aeruginosa* (16.75%). This difference may be due to fact that this study was done only on intubated patients in contrast to our study in which majority of patients were not previouslyintubated.The results from our study showing resistance among gram negative bacteria to commonly used antibiotics is worrisome. Fortunately higher antibiotics show good sensitivity pattern. But we have to be cautious that it also may be short lived if the current trend continues. Our study noted highest mean resistance to cephalosporins which were generally considered to have good action against gram negative bacteria.All patients were on antibiotics while doing the study. Most commonly used antibiotic being the third generation cephalosporin, Cefotaxime. In case of patients in the ICU, antibiotics were chosen by the primary physician, which included higher antibiotics like carbapenems. We were already convinced from previous studies to believe that resistance to cephalosporins in most of the bacteria studied is likely. This deduction is partly due to reason that in most of the patients studied, the antibiotic given, Cefotaxime, with a proven action against Gram Negative Bacteria (GNB), failed to prevent tracheal infection even after one week. In a study by Zakhauret al[13], considerable resistance among GNB of tracheal aspirate was noted in cultures done on tracheal aspirates. Persistent colonization post tracheostomy doesn't also provide a good outlook concerning development of multi-resistant strains causing infection. Various studies have noted the prevalence of GNB in hospitals with multi-resistant forms, a term called healthcare associated pneumonia given in a manuscript by Restrepoet al[18]. Another studyby Aliskanet al[19] has mentioned the higher risk of potential multidrug-resistant pathogens, including resistant gram-negative organisms, especially *Pseudomonas aeruginosa* and *Acinetobacterspps*.

In our study combination of cefoperazone and sulbactumas well as combination of piperacillintazobactamwas found to

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be very effective in most (76.3%) of the cases.Also, ceftazidime was found to be marginally better drug than ciprofloxacin against *Pseudomonas aeruginosa* in the present study. However, this needs further evaluation in various other clinical settings. Ciprofloxacin resistance was found to be the higher among*Klebsiellapneumoniae* and *Pseudomonas aeruginosa* in the present study as compared to Navaneeth BV et al[20], which could be due to its empirical use for treating community-acquired pneumonia, as there is also an increase in resistance to ciprofloxacin among other GNB.

So, from what we have learnt from our study, we recommend the need for serial tracheal suction tip culture for bacteria and antibiotic sensitivity right from the second or third day post tracheostomy, to study the bacteria, note the development of drug resistance early, so that appropriate treatment can be started as soon as possible thus reducing patient morbidity and mortality. Repeated cultures of bacteria during the course of the treatment thus started would allow for the adjustment of therapy according to changes in flora or antibiotic sensitivity

In fact, the risk factors for infection by resistant organisms are similar to those for other nosocomialpathogens such as methicillin-resistant staphylococci, multi-resistant *Acenitobacter*and vancomycin-resistant enterococci, and also include prior antibiotic administration, arterial, venous and urinary catheters, prolonged intubation or tracheostomy in patients with altered consciousness, stay in an ICU, and severity of illness. Studies have shown that a risk factor for infection is also the prior use of antibiotics, especially cephalosporins[21].

Prevention and control measures are important because of the multi-resistant nature of these pathogens. Since this type of anti-microbial resistance appears to be particularly influenced by antibiotic use, antibiotic control measures may also be very important in controlling the spread of resistance. In medical practice, the development of resistance poses serious problems: for the physician on one hand, who must prescribe an active antibiotic that does not select resistant mutants and a problem for the control of infection team on the other hand, whose major concern is to limit the dissemination of multi-resistant organisms. To overcome these problems, the combined competences of clinicians, microbiologists and the infection control team are needed. Now the emphasis is more towards doing a detailed microbiological study and devising a institution specific guidelines for pneumonia treatment[22,23]

Preventive measures would be strictly applied to stop the clonal spread of resistant strains among the patients and/or hospital environment, which occurs if these strains have such opportunity. Last, but not least to be considered is the dosage and administration of anti-bacterials, especially in prophylaxis in intensive care units.

CONCLUSION

We conclude that Gram Negative Bacilli were the predominant isolates of LRT infections post tracheostomy;*Klebsiella pneumonia* and *Pseudomonas aeruginosa* as the commonest isolates. Patients in severe head injury unit with altered consciousness and on prior injudicious antimicrobial therapy are at high risk for contracting lower respiratory tract infections due to resistant GNB. Amikacin, ciprofloxacin and cefoperazone+sulbactum were found to be effective antibiotics against GNB. Clinical experience, coupled with careful physical and microbiological observations, has to be expected to assist the clinicians in treating LRT infections or to guide subsequent changes in antimicrobial therapy. More frequent studies would enable the clinicians to identify any change in the pathogens as well as their sensitivity and hence change in their policy of starting a particular antimicrobial regimen.

Colonization of respiratory tract post-tracheostomy is very swift to occur and monitoring of patients with regular tracheal aspirate culture is the most important investigation to identify it. Patients on tracheostomy are at high risk for contracting lower respiratory tract infections which is predominantly due to GNB like *Pseudomonas aeruginosa, Klebsiella pneumonia* and *Acenitobacterspps*. Bacteria like *Acenitobacterspps* were found to be persistently present in previously intubated patients and who were cared for in an ICU. Factors causing colonisation are many, but it is important for us as clinicians to identify this emergence early and treat the patients promptly. This is most important than ever in this era of multi resistant strains of bacteria.

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CONFLICTS OF INTEREST: The authors hereby report no conflicts of interest pertaining to this study

Table 1: Bacteria studied from the tracheal secretion after a week of tracheostomy

Bacteria	No of patients	percentage
Pseudomonas aeruginosa	34	48.6
KlebsiellaPneumonaie	11	15.7
Staphylococcus aureus	3	4.3
AcinetobacterBaumanni	6	8.6
Enterobacter	1	1.4
Citrobacter	1	1.4
No growth	14	20
total	70	100

Table 2: Antibiotic resistance pattern of gram negative bacteria studied

Antibiotic	No. of resistant gram negative bacteria (Out of total GNB studied viz, 53)
Cefotaxime	33 (62.2%)
Ceftazidime	26 (49%)
Ciprofloxacin	32 (60.3%)
Piperacillintazobactam	8 (15.1%)
Imipenem	3 (5.6 %)
Meropenem	1 (1.8%)
Gentamicin	23 (43.4%)
Cefoperazonesulbactam	10 (18.7%)

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