Original Article:

Endotracheal tube tip culture in post-operative respiratory infections in open heart surgery patients: a one year prospective study

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ABSTRACT

Background: Respiratory tract infections are a common occurrence after open heart surgery, leading to prolonged hospital stay, morbidity and costing the hospital exchequer. This study was conducted to study the utility of post-extubation endotracheal tube [ET] tip culture in providing an early-basis for starting evidence-based antibiotic therapy.

Methods: We retrospectively reviewed the case records of 172 patients who had undergone heart surgery at our tertiary care teaching hospital for occurrence of post-operative infections from clinical and microbiological data.

Results: Bacterial culture was positive in 67(39%) patients. Endotracheal tube patients, grew organisms that were sensitive to empirical antibiotic therapy, in 39 (58%) patients. In 28 (42%) patients organisms resistant to empirical therapy were grown; only 14 of the 28 patients (50%) were symptomatic. *Staphylococcus* was the most common organism isolated followed by *Acinetobacter* and Enterobacter. *Pseudomonas aeruginosa* isolates were sensitive to all the antibiotics tested. Resistance was high among *Acinetobacter* sp. All the Gram-negative bacteria were sensitive to tigecycline. Resistance for beta-lactam antibiotics ranged from 35%-66% with imipenem being the most effective antibiotic.

Conclusion: Our observations provide useful information regarding the microbiology of respiratory infection occurring in post-operative patients who had undergone open-heart surgery. Post-extubation endotracheal tip culture appears to be a useful tool for reliable and accurate diagnosis and treatment of these infections.

Key words: *Respiratory tract infections, Post operative period, Airway extubation, Culture*

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INTRODUCTION

Respiratory infections are a common occurrence after open heart surgery. Typically a post-operative extubated patient begins to show symptoms and signs of respiratory infection after 48-72 hours. Once respiratory infection is diagnosed, treatment strategy is early, swift administration of antibiotics as per culture results. ET tube tip culture provides an accurate and reliable information in this respect and should be routinely included as a part of management protocol.

Post-operative respiratory infections are a major cause of concern in any surgical intensive care unit (ICU). They increase morbidity; prolong ICU stay and are expensive. Despite strict aseptic precautions in the operation theatre and in the post-operative ICU, the prevalence of post-operative respiratory infections in patients receiving endotracheal intubation and mechanical ventilation has been reported to vary between 4% - 28%.[1, 2]

The incidence of respiratory infections in patients who have undergone open heart surgery ranges from 2%-22%.[3-5] With early

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extubation (4-6 hours) nosocomial pneumonia occurred in 7.3% of patients whereas 14.7% of patients extubated after 12 hours had developed nosocomial.[3-5] Apart from intensive pre-post-operative respiratory physiotherapy and early ambulation (based on individual patient recovery), the key to combat respiratory infections is early, appropriate antibiotic therapy. The decision regarding choice of antibiotic has to be based on microbiological culture and sensitivity pattern.

In this study we have attempted to study the utility efficacy of ET tube tip culture as a reliable tool for obtaining early, accurate and representative sample of lower respiratory tract pathogens (which could, in the early post-operative period serve as the causative factor) and there by provide a valuable guidance for antibiotic therapy.

MATERIAL AND METHODS

The case records of 172 patients who underwent open heart bypass surgeries during the period January – December 2013 like coronary artery bypass grafting (CABG), valve replacement and surgery for congenital heart disease [atrial septal defect (ASD), ventricular septal defect (VSD)] in the Department of Cardiothoracic and Vascular Surgery at Sri Venkateswara Institute of Medical Sciences, Tirupati, were reviewed retrospectively.

All patients underwent on pump open heart surgeries with an operating time ranging from four to six hours. They had received post-operative ventilation for a period of 6-12 hours. After extubation, endotracheal tube was sent under sterile conditions for tip qualitative and quantitative culture; ET tube tip cultures were available after 48 hours. All patients had uniform intravenous (IV) empirical antibiotic therapy with third generation cephalosporin, (cefoperazone-sulbactam 1 g thrice-daily), amikacin 500 mg once-daily (amikacin not used in patients with serum creatinine >1.2) that was started 24 hours prior to surgery and continued for five days. IV metronidazole 500 mg thrice-daily was also administered from day 0 to 3 days (for anaerobic coverage).

Six hours post extubation, patients were started on respiratory physiotherapy which consisted of (i) rendering patient pain free by appropriate analgesics; (ii) chest corset; (iii) salbutamol, n-acetyl cysteine and corticosteroid nebulization; (iv) chest physiotherapy including chest tapping, vibration and incentive spirometry, deep breathing and coughing exercises, early ambulation, and pulmonary clearing techniques.

All the endotracheal tips were inoculated on blood agar and MacConkey agar in the Department of Microbiology. The culture plates were incubated at 37 ^{0}C for 48 hours before issuing a negative result.[6] Any growth on the plates was identified by Gram staining and standard biochemical tests. Antibiotic sensitivity was done by Kirby Bauer disk diffusion method as per CLSI guidelines.[7, 8] Patients with ET tip culture positive result were categorized into Group I, II and III based on the antibiogram of the organism and the clinical status of the patient.

Patients in whom isolated organism was sensitive to the empirical antibiotic treatment, patients had one or more indicators of recovery and no indicators of worsening (Table 1). These patients were categorized as Group I. Antibiotic treatment was given for 5 days for these patients.

Patients in whom isolated organism was resistant to the empirical antibiotic treatment; patients observed to have five or more indicators of worsening with in 48 hours of extubation, were categorized as Group-II. Antibiotic therapy was changed in them according to ET tube tip culture sensitivity pattern. These patients progressed to recovery

Table 1: Criteria used for monitoring patients

Indicators of improvement	Indicators of worsening
Absence of dyspnea	Dyspnoea
Absence of tachypnea	Tachypnoea
Absence of discoloration of sputum	Thick, purulent sputum
Absence of CXR abnormalities, namely,	CXR showing pneumonic patch, infiltrates
pneumonic patches, infiltrates etc,	Fever / tachycardia
Absence of fever / tachycardia	SpO_2 falling to < 92% on removal of
SpO_2 > 98% on room air/2L/min nasal oxygen	oxygen supplementation. Dependent on
Ability to swing 2 - 3 sphere on the incentive	mask oxygen, flow rate > 6 L/min
spirometer. (Flow rate = 900 mL/sec -1200mL]	Inability to move > 1 sphere on incentive spirometry
ABG:PaO_2 value ≥ the value obtained while	(Flow rate < 600 mL/s)
breathing room air in the pre-operative period	Low PaO_2 on ABG
Weaning of oxygen within 48-72 hours.	Leucocytosis and thrombocytopenia
Absence of leucocytosis/ thrombocytopenia	

CXR = chest X-ray; SPO_2 = arterial oxygen saturation measured by pulse oximetry; ABG = arterial blood gas analysis; PaO_2 = arterial oxygen tension

with regression of all symptoms within 48-72 hours of starting appropriate antibiotic therapy.

Patients in whom isolated organism was resistant to empirical antibiotic treatment and who were clinically asymptomatic with no indicators of worsening, were categorized as Group III. These patients progressed to complete recovery within 48-72 hours. Antibiotic therapy was not changed.

RESULTS

The mean age of the patients included in the study was 47±15 years; there were 123 (71.5%) males. In 67 (39%) patients ET tube tip culture yielded positive results. Of these, 39 (58%) belonged to Group I (isolated organism sensitive to ongoing treatment and patient clinically asymptomatic); 14 (21%) belonged to Group II (isolated organism resistant to ongoing treatment and patient clinically symptomatic) and the remaining 14 (21%) belonged to to Group – III (isolated organism resistant to ongoing treatment and patient clinically asymptomatic).

In Group I patients organisms were sensitive to the standard antibiotic therapy and thus did not require change of antibiotic and also progressed to recovery without setbacks within 48-72 hours post operatively. In Group II (21%) patients, organism were resistant to the current treatment, showed signs of deterioration post-operatively, received change of antibiotic according to ET tube tip culture, and recovered completely within 48-72 hours after instilling the new antibiotic. Another 21% (Group III) of patients who were also resistant to standard antibiotic therapy but showed no clinical symptoms of deterioration and hence antibiotic was not changed, and patient recovered.

Table 2 depicts the various organisms isolated from these groups. There was no significant difference among the various Gram-positive organisms isolated from the three different groups. But amongst Gram-negative bacilli *Klebsiella Sp* and *E.coli* were not grown from Group III whereas among Group II *Klebsiella Sp* was grown from 2 patients and *E.coli* from one patient. In Group II, the bacteriological profile showed 28% of Gram-negative bacteria causing symptomatic infection and these

patients responded to change of appropriate antibiotic. The overall ET tube tip culture positivity was 39%.

The most common microbe isolated was *Staphylococcus* followed by *Acinetobacter* and *Enterobacter* sp. (n=12 each). Methicillin resistant *Staphylococcus aureus* (MRSA) constituted 38.1%. *Pseudomonas aeruginosa* was isolated in 5 patients which were sensitive to all the antibiotics tested. Resistance was high among *Acinetobacter* isolates. All the Gram-negative bacteria were sensitive to tigecycline. Resistance to β-lactam antibiotics ranged from 35% - 66% with imipenem being the most effective antibiotics. Among non β-lactam antibiotics tigecycline was the most effective antibiotic (100%) and trimethoprim least effective (23%). Table 3 shows the antibiotic sensitivity to β-lactam antibiotics. Table 4 shows the antibiotic sensitivity pattern of isolates for non β-lactam antibiotics.

DISCUSSION

Respiratory infections, ventilator associated pneumonias, etc., are the bane of any post operative ICU. The key to treatment is early identification of the causative microbe, its antibiotic sensitivity profile and administration of culture specific antibiotics.[9-11]

The scenario in a post-operative cardiac surgical ICU is different from that in a medical or respiratory ICU. In a cardiac ICU, patients are post-operatively extubated within 12 to 24 hours post-surgery once they are deemed haemodynamically stable with no surgical complications or contraindications for extubation. In contrast, patients in medical units require ventilation on a long-term basis which could range anywhere between 72 hours to greater than 7 days until even 30 days. Therefore, the patients in this study are those, who have undergone a short period of intubation and ventilation in contrast to patients who are on ventilator for greater than 72 hours.

Table 2: Various bacterial isolates grown from the three groups

Organism	Group I (No.)	Group II (No.)	Group III (No.)
Escherichia coli	3	1	0
Enterobacter	8	2	2
NFGNB	6	2	4
Staphylococcus	14	1	3
Klebsiella	6	3	0
Moraxella	3	0	0
Citrobacter	1	0	0
Pseudomonas	5	0	0

NFGNB = non fermentative Gram negative bacteria

Post-extubation, a cardiac patient is expected to make an uneventful recovery within 48-72 hours. If at this stage, a patient does not do so, and begins to exhibit symptoms of deterioration (Table 1), then a search is made as to what the cause is. In order to effect a change of antibiotic the treating doctors need a microbiological profile of the organism that has infected the patient's respiratory tract and its antibiotic sensitivity pattern. This is where post-extubation ET tube tip culture is of immense value.

Sputum samples are contaminated to some degree with oro-pharyngeal organisms.[12,13] In the immediate post-extubation period, the patient cannot be expected to cough vigorously and provide a satisfactory sample. Also when sputum is thick and inspissated, a satisfactory representative sample may be difficult to obtain.

ET suction catheter samples are widely used for diagnosis, but we have found that they might not provide the appropriate sample as secretions might not be copious on day zero (period of ventilation being only 6-12 hours).[14] We have found that ET tube tip culture provides early, reliable, data about the bacterial pattern of patient's respiratory tract. The reason why ET tubes tip are highly representative of the lower respiratory tract flora are because they act as a nidus for biofilm formation.[15]

Table 3: Antibiotic sensitivity to β-lactam group of antibiotics

Organism	Antibiotic tested						
	AC	**A**	**CFS**	**CE**	**CA**	**I**	**PT**
Moraxella (n=03)	2	1	3	3	NT	3	3
Enterobacter sp. (n=12)	6	5	6	7	NT	6	4
Citrobacter (n=01)	1	1	1	1	NT	0	0
Escherichia coli (n=04)	1	1	3	2	2	2	3
Klebsiella sp. (n=09)	1	1	5	2	2	7	5
NFGNB (n=12)	3	2	5	3	6	8	6
Pseudomonas sp. (n=5)	NT	NT	4	3	3	5	5
Total (n=46)	14	11	27	21	13	31	26

AC = amoxycillin/clavalunic acid; A = ampicillin; CFS = cefoperazone/sulbactum, CE = cefotaxime; I = imipenem; PT = piperacillin/tazobactum, CA = ceftazidime; NT = not tested; NFGNB = non-fermentative Gram negative bacteria

Table 4: Antibiotic sensitivity to antibiotics other than β-lactam antibiotics

Organism	Antibiotic tested									
	AK	**CF**	**CO**	**G**	**CH**	**NT**	**PB**	**T**	**TB**	**TG**
Moraxella (n=03)	3	3	2	3	NT	NT	NT	NT	NT	3
Enterobacter sp. (n=12)	7	5	5	7	7	7	10	7	7	12
Citrobacter (n=01)	1	1	0	0	NT	NT	NT	NT	NT	1
Escherichia coli (n=04)	3	0	0	1	3	3	3	3	3	4
Klebsiella sp. (n=09)	7	5	3	5	7	7	9	9	7	9
NFGNB (n=12)	5	2	3	5	6	6	12	8	6	12
Pseudomonas sp (n=5)	5	3	NT	4	NT	5	5	NT	NT	NT
Total (n=46)	31	19	13	25	23	28	39	27	23	41

AK = amikacin; CF = ciprofloxacin; CO = cotrimoazole; G = gentamicin; CH = cefotaxime; NT = netilmicin; PB = polymixinB; T = tetracycline; TB = tobramycin; TG = tigecycline; NT = not tested

In our study we have found that 39% of patients had growth from ET tube tip. Other studies have reported 33% to 89% positive culture rates.[16] In a study[17] *Acinetobacter* was the most common isolate followed by *Pseudomonas aeruginosa and Staphylococcus aureus.*[17] In our study the three most common isolates were *Staphylococcus*, *Acinetobacter* and *Enterococcus*. This probably is due to empirical antibiotic therapy being directed chiefly against

gram negative bacteria. Others have reported *Psuedomanas aueroginosa* as the most common isolate; the subset of patients with chronic obstructive pulmonary disease (COPD) with long term ventilation.[18,19]

In our study least resistance was observed with tigecycline. Antibiotic with highest resistance was cotrimoxazole. Surprisingly, *Psuedomonas* showed 100% sensitivity to Amikacin whereas in another study, *Pseudomonas* exhibited highest resistance especially to cefixime (70.8%).[18]

It may be argued as to why a Gram-positive coverage and Gram-negative coverage should not be given right at the start of the procedure and continued into the post-operative period. The reasons are: unnecessary injudicious usage of too many antibiotics, high, prohibitive costs, no rationale for starting antibiotic without microbiologic sensitivity results. To the best of our knowledge, there is no similar study available on the utility of ET tube tip culture and antibiotic susceptibility profile among CT surgery patients.

ET tube tip provides the most representative sample of the pathogenic bacteria without any chances of contamination. Also submitting the ET tube tip for culture post-extubation, will provide accurate information about the microbiological profile and its sensitivity pattern within 48 hours. This is the time where patients if colonized with resistant bacteria would begin to show symptoms and if proper information about the pathogen is not available, valuable time is wasted with blind empirical antibiotic therapy. Also if a sample (sputum) is sent i.e., when patient shows no improvement after 48 hours, then it would take another 48 hours for the result to be available during which time bacterial growth would occur unchecked and patient would deteriorate, ICU stay will prolong and morbidity would increase.

Therefore, post-extubation ET tube tip culture would provide a reliable data and guide to antibiotic therapy within 48 hours. If culture is positive, organism is sensitive to the empirical antibiotic therapy and if clinically patient is asymptomatic, he/she is likely to make an early, uncomplicated recovery (as in Group I). If culture is positive with bacteria resistant to the ongoing antibiotic therapy, a simple change of antibiotic according to ET tube and sensitivity testing culture would hasten and assure speedy recovery (as in Group II). If a situation arises as in Group III, where microbiological resistance is demonstrated but patient is asymptomatic, then clinical judgment takes precedence over laboratory results. It would be prudent to observe the patient closely and decide on the appropriate course of action based on progress / deterioration. Prospective studies on ET tube tip culture, head-to-head comparison of ET tube tip versus ET suction catheter and sputum culture and their relative sensitivity and specificity in bacterial identification would shed interesting light on the subject.

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