International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

A Study of Post Extubation Endotracheal Tube Microbial Colonisation in Patients Undergoing Elective Postoperative Mechanical Ventilation

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1. Introduction

An increasing number of patients with co-morbidities are being subjected to elective post-operative ventilation to facilitate recovery after major and complex surgical procedures. Mechanical ventilation, despite benefits has been reported to increase the incidence of postoperative chest infection by 50 %[1] with a fourfold to tenfold increase in mortality in critically ill patients.[2,3,4]

A patient developing pneumonia more than 24 hrs after commencing mechanical ventilation is said to have ventilator associated pneumonia.[5]

Prior knowledge of the microbes colonizing the endotracheal tubes in situ and their antibiotic sensitivity spectrum can prevent the dreaded complication of VAP.

Till date no such data is available for patients admitted to the ICU in our institution.

The present study was planned to study the endotracheal tube microbial colonization in patients undergoing postoperative elective mechanical ventilation in our ICU.

2. Aims and Objectives

The research was conducted to study the microbial colonisation of endotracheal tube in patients undergoing elective postoperative ventilation and the proportion of patients developing respiratory infections postoperatively. The antibiotic sensitivity of micro-organisms cultured was analysed and an attempt to correlate the microbial colonisation with duration of tracheal intubation and nature of respiratory infections was made.

3. Materials and Methods

Study design: It was a laboratory based observational study conducted from November 2014 to March 2016. A total of 100 patients aged 18-65 years, either sex, belonging to ASA I and II, and subjected to elective postoperative mechanical ventilation for <96 hours were included in the study.

4. Methods

After a written informed consent, patients advised elective postoperative ventilation were mechanically ventilated on Controlled Mechanical Ventilation (CMV) / synchronized intermittent mandatory ventilation (SIMV) mode with or without pressure support and Positive end expiratory pressure (PEEP) as deemed fit and nursed with all aseptic precautions to maintain sterility.

On fulfilling the extubation criteria, the trachea was extubated, the endotracheal tube flushed with 5 ml of isotonic saline, the irrigate collected in a sterile container and subjected to culture on blood agar, chocolate agar, and Mac conkey media within an hour of collection. The antibiotic sensitivity was studied using the Kirby Bauer disk diffusion method using CLSI guidelines against selected antibiotics.

All patients were followed up for 72 hours after tracheal extubation, and a note made of the presence of cough with/without expectoration, fever and adventitious sounds (crepitations, rhonchi) in chest. Presence of cough with/without expectoration with fever and / adventitious sounds in chest were taken as post operative chest infection.

5. Results

Mean age and sex distribution:
The youngest patient was 18 yrs of age and the eldest 65 yrs old. Majority (68%), were young adults ranging from 20 - 40 yrs. The mean age was 34.28 ± 12.07 yrs. Females outnumbered the males.

Table 1

	Mean	±SD
Age(yrs)	34.28	12.07
Weight(kgs)	58.30	7.37

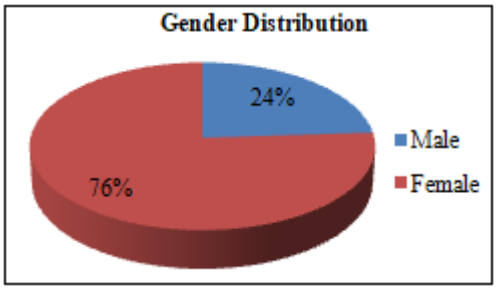

Figure 1
(p-value < 0.001)

Mean duration of surgery and blood loss

Table 2

	Mean	±SD
Duration of surgery (hrs)	2.56	0.85
Estimated blood loss (L)	2.23	0.89

The surgeries lasted from 1 hr to a maximum duration of 6 hrs and the average duration of surgery was 2.56±0.85 hrs. The mean estimated blood loss for patients was 2.23 ±0.89 L.

Indications for elective postoperative ventilation

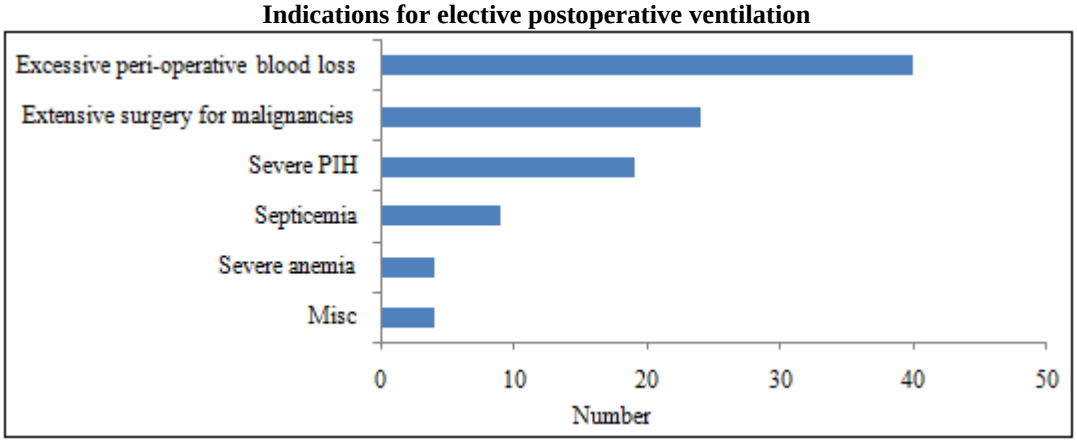

Figure 2

Peri-operative major blood loss was the most common (40%) indication for elective postoperative ventilation. Other indications included lengthy extensive surgery for malignancies (24%), pregnancy induced hypertension with associated multisystem complications (19%) and patients with septicaemia and severe anaemia.

Duration of elective postoperative ventilation

In the study group, 17 patients were extubated within 24 hrs of elective ventilation, 31 patients at 24 hrs & 17 patients between 24-48 hrs. Extubation criteria were fulfilled between 48-72 hrs in 22 patients. The remaining 13 patients were extubated between 72-96 hrs.

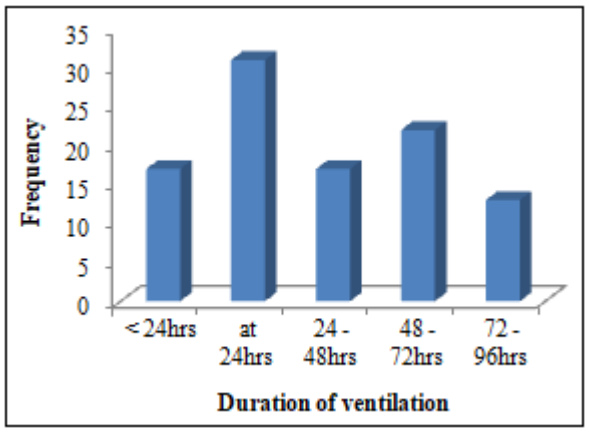

Figure 3

No microbial growth on culture was reported in patients extubated within or at 24 hrs of elective ventilation. Tracheal irrigate samples of all patients extubated after 72 hours were positive for microbial growth. Cultures were positive for microbial growth in only 3 patients (17.6%) extubated between 24-48 hrs. Of the 22 patients, extubated between 48-72 hrs, a positive microbial growth was obtained on the culture medium in 81.8% (18 patients).

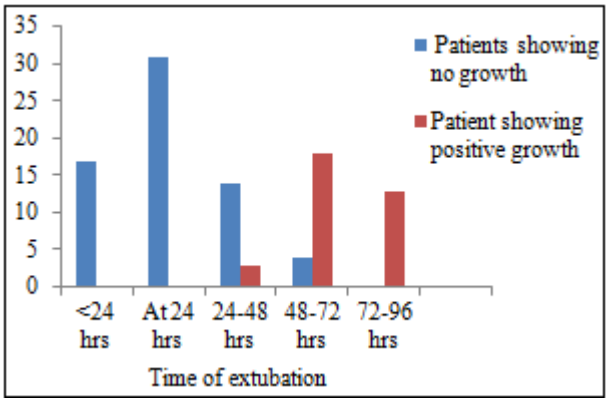

Figure 4

Micro-organisms isolated

Tracheal irrigate samples tested positive for microbial growth in 44 patients. While all patients extubated after 72 hours (100%) had developed microbial colonization, the evidence for microbial growth was obtained in 81.8% of patients extubated between 48 and 72 hrs and in only 17.6% for patients extubated between 24 and 48 hrs.

Table 3

Time Of Extubation	Samples Showing No Growth	%
<24 hrs	17	100
At 24 hrs	31	100
24-48 hrs	14	82.3
48-72 hrs	4	18.2
72-96 hrs	0	-

Table 4

Microbial Growth	n
No growth	66
Acinetobacter	14
E.Coli	1
Klebsiella	12
Methicellin sensitive staph	1
MRSA(coagulase negative)	1
Proteus sp.	1
Pseudomonas	4
TOTAL	100

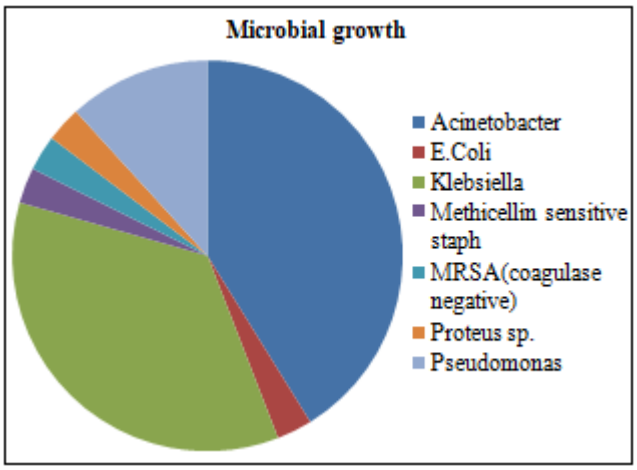

Figure 5

Acinetobacter was the most common microbe identified (14/44) closely followed by Klebsiella (12/44). Pseudomonas was isolated in 4 patients and E.coli, Proteus, methicillin sensitive staph and methicillin resistant staph in one patient each.

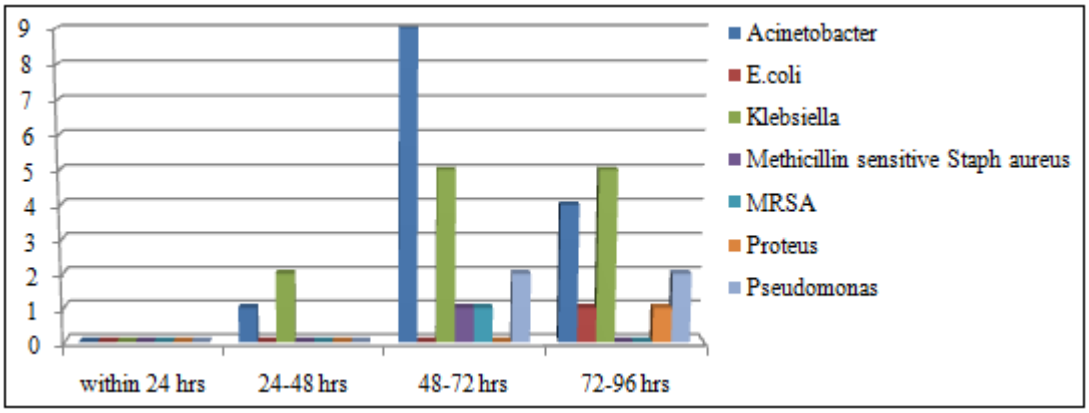

Figure 6

Post extubation signs and symptoms at < 24 hours of mechanical ventilation

Table 5

	At 24 hrs	At 48 hrs	At 72 hrs
Cough	2	0	0
Cough with expectoration	0	0	0
Fever	0	1	0
Adventitious sounds	0	0	0

None of the patients extubated in <24 hrs developed cough with expectoration or adventitious sounds in chest. Only 2 patients developed dry cough at 24 hrs and 1 patient developed fever at 48 hrs. Both these symptoms resolved within a day.

Post extubation signs and symptoms at 24 hours of mechanical ventilation

Table 6

	At 24 hrs	At 48 hrs	At 72 hrs
Cough	23	6	1
Cough with expectoration	1	1	0
Fever	0	2	4
Adventitious sounds	0	0	0

Dry cough was noted in 23 patients which subsided in 17 patients in the next 24 hours and in the remaining 6 patients, after 48 hours.

Cough with expectoration was noted in one patient. This too was relieved by 48 hrs, but dry cough persisted at 72 hrs. A total of 4 patients developed fever; 2 after 48 hrs and 2 after 72 hrs.

Post extubation signs and symptoms at 24 – 48 hours of mechanical ventilation

14 out of 17 patients (82.3%) extubated within 48 hrs of ventilation developed a dry cough which persisted for 48 hrs in 5 patients and 72 hrs in 2 patients. One of these had fever as well.

4 patients developed cough with expectoration. In 3 it resolved in 48 hrs and in the remaining 1 patient it persisted even at 72 hrs. One of these patients also had accompanying pyrexia. The pyrexia in both patients persisted even at 72 hrs.

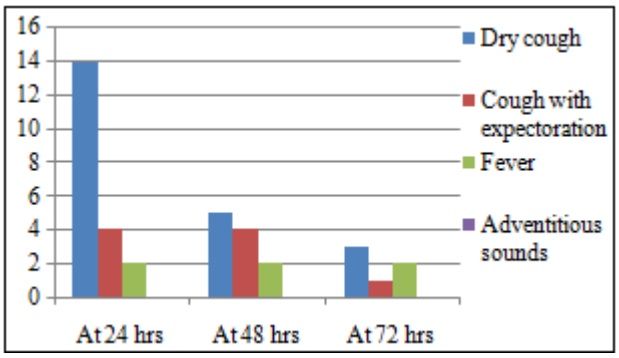

Figure 7

Post extubation signs and symptoms at 48 - 72 hours of mechanical ventilation

Table 7

	At 24 hrs	At 48 hrs	At 72 hrs
Cough	4	3	2
Cough with expectoration	18	17	13
Fever	7	9	5
Adventitious sounds	1	1	1

All the 22 patients extubated 48-72 hrs after elective ventilation developed signs and symptoms. 18 (81.8%) developed cough with expectoration; while the remaining 4 had dry cough. One of these also had adventitious sounds in chest. Seven patients were found to be febrile. Two more patients developed fever the next morning. The follow up next day at 72 hrs revealed that cough with expectoration had resolved in 5 patients but persisted in remaining 13 patients and the pyrexia had resolved in 4 patients.

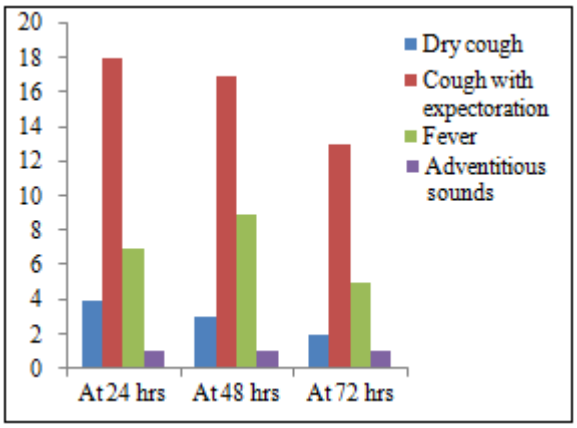

Figure 8

Post extubation signs and symptoms at 72 - 96 hours of mechanical ventilation

Table 8

	At 24 hrs	At 48 hrs	At 72 hrs
Cough	1	1	0
Cough with expectoration	12	11	11
Fever	8	9	8
Adventitious sounds	2	5	4

Of the 13 patients extubated after 72 hrs, 12 developed cough with expectoration which persisted even on the 3rd post extubation day. 8 patients had fever and 4 had adventitious sounds in chest even at 72 hrs.

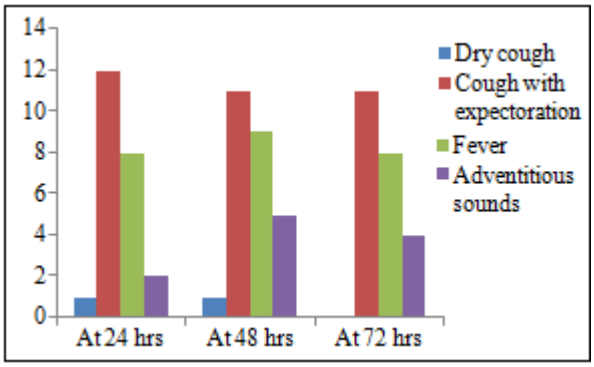

Figure 9

Incidence of postoperative chest infection in the present study

13 patients electively ventilated, qualified to be labelled as having chest infection as per predetermined criteria.

Post extubation signs and symptoms in patients with no microbial growth

39 patients developed dry cough (59%) within 24 hr of extubation , which resolved in 95% of the patients at the end of 72 hrs. Only 5 patients developed cough with expectoration. This too subsided in 80% by 72 hrs.

Fever was recorded in 2 patients at 24 hrs, 5 patients at 48 hrs and 6 patients at 72 hrs. This was attributed to surgical causes such as pelvic collection; as these patients were females and subjected to complicated obstetric surgery and did not have other signs of chest infection.

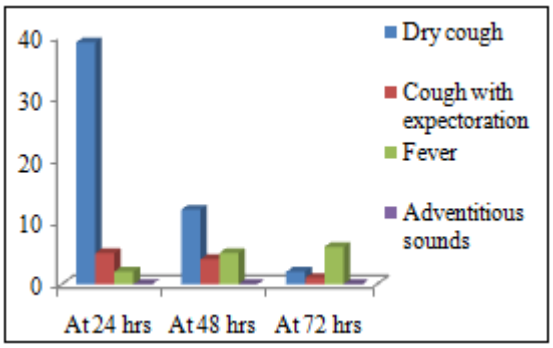

Figure 10

Comparison of symptoms and signs in patients with positive and negative microbial growth

At 24 hrs

Table 9

	Growth (n=34)	No Growth (n=66)	P value
Dry Cough	5	39	0.003
Cough with expectoration	30	5	<0.001
Fever	15	2	<0.001
Adventitious sounds	3	0	<0.001

Cough with expectoration and fever were the most common symptoms (88.2% and 44.1%, respectively) in patients who had a positive microbial growth in the tracheal irrigate. This was statistically highly significant (p<0.001). Dry cough was noted in a significant number (59.1%) of patients in whom the tracheal irrigate cultures were reported negative. Most of them did not develop any other symptom and the dry cough was attributed to irritation due to presence of endotracheal tube in situ

At 48 hrs

Table 10

	Growth (n=34)	No Growth (n=66)	P value
Cough	3	12	0.775
Cough with expectoration	16	4	<0.001
Fever	10	5	<0.001
Adventitious sounds	4	0	<0.001

Observations at 48 hrs were similar to those at 24 hrs with a statistically highly significant (p<0.001) cough with

expectoration and fever being the most common symptom in patients with positive microbial growth (47.1% and 29.4% respectively)

At 72 hrs

Table 11

	Growth (n=34)	No Growth (n=66)	P value
Cough	4	2	0.235
Cough with expectoration	24	1	<0.001
Fever	13	6	<0.001
Adventitious sounds	5	0	<0.001

Observations at 72 hrs closely followed those at 24 and 48 hrs. Cough with expectoration (70.6%) and fever (38.2%) remained the dominant symptoms in patients who tested positive for microbial growth, which was statistically highly significant (p<0.001).

Antibiotic sensitivity of microbes isolated

Table 12

	Acinetobacter %	Klebsiella %	Pseudomonas %
Colistin	85.7	50.0	25.0
Levofloxacin	21.4	16.7	25.0
Ciprofloxacin	14.3	25.0	25.0
Gentamicin	14.3	41.7	50.0
Amikacin	-	41.7	50.0
Imipenem	-	41.7	50.0
Ceftazidime	-	-	50.0
Piperacillin -tazobactem	-	25.0	50.0

Acinetobacter was found to be sensitive to colistin in 85.7% and to levofloxacin in 21.4%. Percentage sensitivity to both ciprofloxacin and gentamicin was 14.3 each.

Klebsiella was maximally sensitive to colistin (50%) followed by gentamicin, amikacin and imipenem(41.7% each) and least sensitive to levofloxacin(16.7%).

Culture sensitivity for Pseudomonas was reported positive in 50% to gentamicin, amikacin, imipenem, ceftazidime and piperacillin-tazobactem; each. The same was reported to be much less, i.e. 25% for colistin, ciprofloxacin and levofloxacin.

Table 13

	E.coli	Methicillin sensitive Staph	Methicillin resistant Staph	Proteus
Colistin				
Levofloxacin				
Ciprofloxacin				
Gentamicin	+	+	+	+
Amikacin	+			
Imipenem	+			
Ceftazidime				
Vancomycin			+	

Of all the samples tested, cultures were reported positive for E.coli, Methicillin sensitive Staph aureus, Methicillin resistant Staph aureus and Proteus in only 1 sample each. While all these organisms were sensitive to gentamicin, E.coli was also found to be sensitive to imipenem and amikacin; and Methicillin resistant Staph to vancomycin as well.

Table 14

	Acinetobacter	Klebsiella	Pseudomonas	E.coli	Methicillin sensitive	MRSA	Proteus
Colistin	+	+	+				
Levofloxacin	+	+	+				
Ciprofloxacin	+	+	+				
Gentamicin	+	+	+	+	+	+	+
Amikacin	-	+	+	+			
Imipenem	-	+	+	+			
Ceftazidime	-	-	+				
Piperacillin -tazobactem		+	+				
Vancomycin						+	

Klebsiella and Pseudomonas were found to be sensitive to majority of antibiotics tested. While Acinetobacter, Klebsiella and Pseudomonas were also sensitive to colistin, levofloxacin and ciprofloxacin; E.coli was found to be sensitive to amikacin and imipenem.

Antibiotic resistance in the microbes isolated

Table 15

	Acinetobacter %	Klebsiella %	Pseudomonas %
Colistin	-	-	-
Levofloxacin	-	-	-
Ciprofloxacin	57.1	50.0	
Gentamicin	42.8	33.3	50.0
Amikacin	64.3	41.7	50.0
Imipenem	28.6	25	50.0
Ceftazidime	64.3	75	50.0
Piperacillin -Tazobactem	57.1	50	25.0
Amoxyclav	71.4	83.3	
Tazobactem	100	100	

100% resistance was found to tazobactem in all cultures positive for Acinetobacter and Klebsiella. High resistance was also observed to ciprofloxacin, amikacin, ceftazidime and piperacillin-tazobactem combination.

6. Discussion

A total of 100 patients of either sex in age group 18-65 yrs, belonging to ASA I and II, and subjected to post-operative elective ventilation were included in the study. Females outnumbered the males. The mean age and weight was 34.28 ± 12.07 yrs and 58.30 ± 7.37 kgs respectively.

Positive microbial growth

Of the 100 tracheal irrigate samples collected post extubation and subjected to culture and sensitivity in the present study; no microbial growth was noted in patients extubated at ≤ 24 hrs of mechanical ventilation. In all 44 samples tested positive for microbial growth.

Girou E et al in 2004 stated that in 80% of the patients, microbial growth was confirmed in trachea even after 1 day of mechanical ventilation [6]

In the present study the most common microbe isolated was Acinetobacter (31.8%), closely followed by Klebsiella (27.3%) and Pseudomonas (9.1%). E.coli, Proteus, methicillin sensitive Staphylococcus aureus and MRSA were also isolated, each constituting 2.3% of the total.

Chest infection with Staph aureus in 21.3%, Enterobacteriaceae in 17.9%, Pseudomonas aeruginosa in 15.9%, non pneumococcal streptococcus in 13.5% and Acinetobacter baumanii in 9%.was reported by Trouillet et al[7].

Medell et al[8] also identified Acinetobacter baumanii, Pseudomonas aeruginosa and Serratia spp as causative agents in 68.9%, 44.2% and 19.5% of chest infections respectively. They also reported an incidence of 15.6% each of Klebsiella pneumonia and E.coli pneumonitis.

Acinetobacter was isolated in 50.6% of VAP by Montero et al[9]

Tracheal aspirate positive for Acinetobacter baumanii in 38.7%, Klebsiella in 17.3%, and Pseudomonas aeruginosa in 16.7% was reported by Chittawatanarat et al[10]. They also stated that Staph aureus cultures were obtained in 4% and that it was the most common gram positive organism isolated.

Pseudomonas colonization of trachea in high proportion of severely ill intubated patients was reported by Ohman et al[11]. He also reported anerobic bacterial colonization which included Peptostreptococcus and Prevotella.

Cultures positive for Staph, Strep pneumonia, Pseudomonas aeruginosa, Hemophilus spp were reported by George DL et al[12] in 65% of samples tested for suspected lower repiratory tract infections.

Antibiotic sensitivity

In the present study, Acinetobacter was found to be most sensitive to colistin in 85.7%. It was also found sensitive to levofloxacin in 21.4%, to ciprofloxacin in 14.3% and to gentamicin in 14.3%.

Klebsiella was found to be sensitive to colistin in 50%; and equally sensitive to gentamicin, amikacin and imipenem in 41.7%. In 16.7% cases it was also sensitive to levofloxacin.

Culture sensitivity for Pseudomonas was reported positive in 50% to gentamicin, amikacin, imipenem, ceftazidime and piperacillin-tazobactem each. In 25%, Pseudomonas was also found sensitive to colistin, ciprofloxacin and levofloxacin, each.

Tasbakan MS et al[13] reported efficacy of colistin in 66.7% cases with VAP due to pan-resistant Pseudomonas aeruginosa and Acinetobacter baumannii .

Medell et al[8] reported 98.1% sensitivity to colistin in Acinetobacter infection. Resistance to gentamicin was found to be maximum and least for colistin.

Colistin susceptibility was confirmed in 63.4% imipenem resistant strains of Acinetobacter isolated by Montero et al[9]

Antibiotic resistance

In the present study Acinetobacter was found to be resistant to amoxyclav, amikacin, ceftazidime, ciprofloxacin and piperacillin – tazobactum combination in more than 50% cases.

Similarly Klebsiella was found to be resistant in over 50% to amoxyclav, ceftzidime, piperacillin – tazobactum combination and ciprofloxacin.

Pseudomonas resistance to gentamicin, amikacin, imipenem and ceftazidime was observed in 50% cases each.

A 100% resistance to tazobactum was noted for both Acinetobacter and Klebsiella.

Chittawatanarat et al(10) reported no resistance to colistin for gram negative organisms and no resistance to vancomycin for gram positive organisms. They further reported that Acinetobacter showed 82.8% resistance; Klebsiella 30.8% resistance and Pseudomonas aeruginosa 28% resistance, to the empirical antibiotic therapy.

The incidence of multidrug resistance was reported to be 40% and 37.5% respectively for Pseudomonas aeruginosa and Acinetobacter, by Golia S et al(14).

A high frequency of multidrug resistance for Acinetobacter baumanii, Pseudomonas aeruginosa and MRSA was also observed by Camargo LF(15).

An incidence of 28%, 26% and 16% multidrug resistant VAP with MRSA, Pseudomonas aeruginosa and Acinetobacter baumanii respectively has been reported by Trouillet et al(7).

Chest infection after mechanical ventilation

Incidence of post-operative chest infection in patients electively ventilated in ICU in the present study was 13%.

An 8% incidence of pneumonia has been reported in all patients ventilated for ≥ 48 hrs by Magnason S et al[16]

Golia S et al[14] reported the incidence of VAP to be 35.14 % out of which 44.23% had early onset (<4 days mechanical ventilation) and 55.77% had late onset VAP (>4 days mechanical ventilation).

VAP was suspected in 38% patients ventilated mechanically for >48 hrs by Shahin J et al [17].

Hyllienmark P et al[18] reported that 15% patients admitted to the ICU developed VAP.

Observations of Safdar N et al[4] indicate that between 10-20% patients receiving >48 hrs mechanical ventilation develop VAP.

7. Summary

1) No microbial growth was observed in patients extubated within 24 hrs of elective postoperative ventilation.
2) All samples after 72 hrs and a few after 48 hrs of elective postoperative ventilation tested +ve for microbial colonisation.
3) Acinetobacter was the most common microbe isolated. Klebsiella and Pseudomonas were the other two common microbes isolated.
4) Symptoms suggestive of chest infection were common after ≥ 48 hrs of mechanical ventilation.The incidence of chest infection found to be 13 % in the present study.
5) Sensitivity to colistin was very high, 85.7% for Acinetobacter and 50% for Klebsiella.
6) Pseudomonas was found sensitive in 50% to gentamicin, amikacin, imipenem, ceftazidine and piperacillin-tazobactum.

8. Conclusions

1) Risk of tracheal microbial colonization and potential chest infection is nil or negligible with elective post operative ventilation of ≤ 24 hrs.
2) Risk of microbial colonization in trachea and potential chest infection increases with duration of mechanical ventilation, with a 100% incidence of positive microbial growth with duration of ≥ 72 hours of ventilation.
3) Microbes isolated in the present study were most sensitive to colistin
4) Resistance to colistin not seen for the three most common microbes isolated in the present study.

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