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Research Article

Study of Development of Pneumonias in Patients undergone Neurosurgical procedures in Health Care Institutions

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Abstract

Ventilators induced pneumonias are usually associated with some predisposing risk factors. Predisposing factor which were taken into account during this study were prior antacids, prior aspiration, alcoholism, smoking, prior hospital stay and underlying diseases which includes chronic lung disease, diabetes mellitus, neoplasia and heart insufficiency, antibiotic therapy. 50 such case undergone neurosurgeries were studied and detailed analysis is presented.

Keywords: Pneumonia; Ventilator; Consolidation; Hospital acquired infection; Hospital associated infection; Kerby-Bauer method

Introduction

Pneumonia is the most important complication in patient on assisted ventilation. It is also the most frequent hospital associated infection leading to death. The normal defence mechanism in these patients are bypassed and respiratory tract is led open to colonisation. This is undesirable since at that situation bacteria are placed advantageously to invade lung parenchyma.

In addition, the result of culture of lung aspirate, which are contaminated with tracheal organism, are made more difficult to interpret.

The bacteria involved have been shown to originate from different sources e.g. Respiratory equipment, nasogastric feeding, other patient and endogenous sources as faeces and other colonised sites in patient. Bacteria from these sources have been found on hands of staff and other vehicles of spread, but route of entry in trachea is less clear. There are two potential common pathways by which bacteria may enter in to trachea-

1) Through the airway of endotracheal tube or tracheostomy tube via inhaled air during suction.
2) Via contaminated oropharyngeal or gastric secretion passing between end tracheal tube and trachea.

Bacteria passes through a tracheostomy tube wound can also occur, but is less important because wound receives protection from infection.

The air delivered to patient may carry bacteria entrapped from a contaminated part of respiratory equipment or from air of unit

itself. However much emphasis is placed on preventing bacterial contamination of respiratory equipment and ventilators are generally decontaminated after use by efficient processes. Humidifiers are generally filled with sterile water and are stored dry between patients. Respiratory tubing's are changed frequently.

Less work has been done on bacterial contamination of air of i.c.u., but common experience and available evidence tend to indicate that it is of little importance. In any case, in cross infection episode, the pattern of spread of tracheal isolates between patients is typical of contact spread. Contamination of inspired air from retrograde movements of tracheal secretion into respiratory line could occur after tracheal colonisation.

Material and method

Fifty patients in the neuro-surgery i c u of our hospital receiving mechanical intubation were studied. Patients were randomly selected.

Patients with short term (<48 hrs.),and long term ventilation therapy (>48 hrs) were included .Each patient was ventilated via an endotracheal or tracheostomy tube connected to one of the following mechanical ventilators.

Data collection

Daily patient temperatures, laboratory results, underlying disease and drug therapy was recorded prospectively on standardized forms.

The diagnosis of ventilation associated pneumonia required four of the following five criteria developing not less than 48 hours after the start of mechanical ventilation: -

1) A new and persistent infiltrate in a chest x-ray.
2) Purulent tracheal secretion
3) A significant pathogen isolated from cultures of tracheal aspirate
4) Body temperature above 38
5) Peripheral leukocyte count of more than 10,000/cumm

Physical signs of pneumonia

Following of these criteria, cough, fiver, sputum, breathlessness, with fall in saturation may be present in combination. Positive chest x-ray must always be present.

Coma was defined as score of 8 by the Glassgowcoma score. Most of the patients were between 5 and 7 of G.C.S. The acute physiological score quantities abnormalities in the patients vital signs , mental status, and organ function on the basis of the most abnormal values and physical signs with 24 hours of admission to i.c.u.

Medication such as antibiotics,steroids, antacids, vasopressors and pancuronium bromide (pavlon) and bronchodialators were recorded. Each medication was considered a potential risk factor for pneumonia if given when patient was receiving mechanical ventilation and prior to pneumonia. Personal history of the patient regarding alcoholism, smoking were recorded which also included in predisposing factors.

Other predisposing factors are also recorded which included prior aspiration, prior hospital stay, chronic lung disease, diabetes, neoplasm and heart insuffiency.

Microbiological sampling

1) Reservoir samples were collected after 24hrs of ventilation and promptly cultured for bacteria and fungi. All plates were incubated at 37°c for 48 hrs.
2) trachea-bronchial secretions - culture of tracheal secretions were collected by suction directly from the lower respiratory tract via the tracheostmyor endotracheal tube organisms were identified according to routine microbiological methods. No cultures were made for anaerobic bacteria, legionella, mycoplasma, or viruses.
3) Other cultures: nasal and throat swab were collected to identify organism being carried at these sites.
4) Blood and urine culture were also done in the entire patient to exclude any previous infection in the patients

Antibiotic sensitivity of different organism was done by the Kerby- Bauer method. Sensitivity test were done for the following antibiotics – ampiciillin, cephaazolin, chloramphenicol, carbenicillin, kanamycin, cotrimoxazole, tetracycline, cloxaacillin, erythromycin, lincomycin, cefotoxime, ceftazidine, streptomycine, colistin, gentamycin, polymixin–b. Strains with similar antibiotic sensitivity pattern up to a difference of two were considerd to be the same.

Procedure for decontamination of ventilator apparatus

1) Ventilator tubing changed every 48 hrs and decontaminated by ethylene oxide gas.
2) Reservoir fluid was changed daily
3) A new suction catheter used for every suction procedure.

Patients included in the study were suffering from different neurosurgical problems which included the broad subgroups as supratentorial mass lesion, vascular pathology, mainly aneurysm, and AVM , posterior fossa masses include both midline and c.p. angle brain stem masses , hydrocephalus – congenital and post meningitic, head injuries, and high cervical cord compression. Studied patient belongs to different age groups.

Age variations: Youngest patient was 4 years old and oldest was 78 years old. Most of the patients were between 3rd and 5th decades.

Demographic characteristic in the 50 studied patients are shown in table 1, 2 and 3.

Age in years	*No. of patient*
1 -10	7 (14%)
11-20	4
21-30	7
31—40	12(24%)
41-50	7
Above 50	13(26%)
Total	50

Table 1: Age of the patients.

Sex	*No. of patients*
Male	38(76%)
Female	12(24%)
Total	50

Table 2

Supratentorial mass lesion	19(38%)
Infra tentorial mass lesion	10(20%)
Hydrocephalus	6
Vascular lesion	8
High cervical cord compression	3
Head injury	4
Total	50

Table 3: Clinical diagnosis at admission.

Characteristic of the 50 patients on admission to the i.c.u. are shown in table-4. All these patients were between 5 and 7 of g.c.s.

Most of the patients studied were already present in the hospital for more than two days. Out of which 22 patients (44%) had history of prior aspiration, 26 patients (52%) of prior antacids, 4 (8%) patient had history of alcoholism and 20(40%) patient has history of smoking. Hospital stay was 1 day in 4 (8%) patient, 2-7 days in 8 (16%) patients, more than 7 days in 38 (76%) patient, 23 (46%) had underlying disease in form of chronic lung disease, neoplasia or heart disease. Thirty seven patients were already on antibiotics.

Out of the 50 patient included in study, 23 develops pneumonia. The probable predisposing factors to the development of pneumonia in this patient are given in table-5.

Characteristics	***No. of patients***
Prior aspiration	22 (44%)
Prior antacids	26 (52%)
Alcoholism	4 (8%)
History of smoking	20 (40%)
Prior hospital stay	
1 day	4 (8%)
2-7 days	8 (16%)
More than 7 days	38 (76%)
Antibiotics	37 (74%)
Glasgow coma scale (between 5-7)	50 (100%)
Underlying disease(chronic lung diseases), diabetes, neoplasia, heart insufficiency	23 (46%)

Table 4: Characteristics of 50 patients on Mechanical, ventilation.

Five independent variables were significantly associated with ventilator as associated pneumonia. Histories of prior aspiration were found in 22 (44%) patients out of whom 15 patients (68.1%) associated with pneumonia. Histories of alcoholism were present in 4 patients (8%) of which 2 patents (50%) associated with pneumonia. Other significant factors were prior hospital stay between 2-7 days administration of antibiotics and more than 48 hours duration on ventilator.

Predisposing factors	*No. of patients*	*Pneumonia*
Prior aspiration	22 (44%)	15 (68.1%)
Prior antacid	26 (52%)	11 (42.3%)
Alcoholism	4 (8%)	2(50%)
Smoking	20 (40%)	9 (45%)
Prior hospital stay		
1 day	4 (8%)	1 (25%)
2-7 days	8 (16%)	5 (62.5%)
More than 7 days	38 (76%)	17 (44.7%)
Antibiotics	37 (74%)	23 (66%)
Underlying diseases	23 (46%)	8 (30.4)%
Duration of ventilation		
Less than 48 hours	6	1 (28%)
More than 48 hours	44	22 (50%)
Total	50	23 (46%)

Table 5

Bacteriological study

The organisms isolated from various sites in the 50 study patients are shown in table 6. The gram negative bacilli were the most frequent group of organisms isolated from the different sites. Klebsiella pneumonia was most common, next was pseudomonas aeruginosa followed by escherichia coli.

Organisms	**Tracheal**	**Reservoir**	**Urine***	**Nosc/throat****	**Total**
P. Aeruginosa	9	6	4	1	20
K. Pneumoniae	26	1	9	2	38
E. Coli	2	1	6	2	12
Staph aureus	5	-	-	2	7
Proteus sp.	1	-	-	-	1

Table 6: Organism isolated from various site in 50 patients on mechanical ventilation.

* Similar organisms in urine and tracheal aspirate were found in 10 patients. In 9 patients organisms were different.
* Similar organisms in nose/throat, and tracheal aspirate were found in 2 patients. In 5 patients organisms were different.

The various organisms isolated from the tracheal aspirate of the 23 cases, which developed pneumonia is given in table 7.

Gram negative bacteria were the predominant organisms being isolated from 82% of tracheal aspirates of patients who developed ventilator associated pneumonia. In many of the aspirates more than one organism were isolated. The most common organism isolated were klebsiella species (60.1%), pseudomonas aeruginosa (39.1%), proteus species (8.9%).

Table 7

Pneumonia developed in the majority of cases (80%) after 7 days of ventilator therapy.

Organisms	*No. of patients*
P. Aeruginosa	6
Klebsiellapneumonia	1
E. Coli	1
Aerobic spore bearers	1
Acinetobactor sp.	1
Total	10 (20%)

Table 8: Reservoir fluid colonized with bacteria.

Six of these 10 patients acquired ventilator associated pneumonia. In 6 patients, the bacteria isolated from the reservoir sample (one klebsiellapneumoniae, 5 pseudomonas aeruginosa) were found to be the same organisms as cultured from trachea secretions. All the six patient in whom the reservoir fluid and tracheotomy or intubation aspirate culture where same, developed pneumonia; whereas 3 of the remaining 4 patients where there was no correlation between reservoir fluid and tracheotomy or aspirate bacteriology developed pneumonia. In these patients tracheal secretions were probably the source of reservoir colonization while in the four patients where the bacteria isolated from the reservoir samples (one E. coli, one pseudomonas sp., one aerobic spore bearing organism and one acinetobactor sp.) did not correspond with those recovered from tracheal aspirates, tracheal secretions were probably not the source of contamination of reservoir (table 9).

Most of the pateints, whose prior hospital stay were between 2-7 days or more than 7 days showed organisms in the tracheostomy/ intubation aspirate or nasal/throat swab or urine. Mechanical ventilator induced pneumonia by nosocimial organisms were more common in patients with prolonged hospital stay.

Duration of mechanical ventilation is also improtatn. Patients, who were electrively ventilated for less than 48 hours, did not show any eviedence of infection baring a few patients. Mostly infection and mechanical ventilators induced pneumonia seen in patients who were ventilated for more than 48 hours.

Organisms grown in Reservoir fluid	*Organisms grown In tracheostomy Or endotracheal Aspirate*	*No. of patients*	*Pneumonia*
P. Aeruginosa	Pseudomonas Aeruginosa	5	5
Klebsiellapneumoniae	Klebsiellapneumoniae	1	1
E. Coli	Klebsiellapneumoniae	1	1
Aerobic spore Bearing bacilli	Klebsiellapneumoniae	1	1
Pseudomonas sp.	Proteus Mirabilis	1	1
Acinetobactor sp.	Klebsiellapneumoniae	1	1
	Total	10	9

Table 9: Bacteriology of tracheal aspirate and reservoir Fluid in 9 cases of pneumonia in whom The ventilator humidifier was contaminated.

	Ventilator Associated Pneumonia	*No ventilation Associated Pneumonia*	*Total*
Total no. of patients with ventilators	23	27	50
Tracheal aspirate	23	19	42
Reservoir fluid	9	1	10
Urine	13	6	19
Blood	2	-	2

Table 10: Correlation between ventilators associated pneumonia and culture positive tracheal aspirate, reservoir Fluid, blood and urine culture.

Discussion

Previous investigators have identified several risk factors for the development nosocomial pneumonia (Hooter TM et al 1981) [1]. Although most patients who develop hospital acquired pneumonia do not have artificial airways, patients who receive mechanical ventilator via an orotracheal or nastrachea tube have a substantially increased risk of lower respiratory tract infection (Cross AS, Roupe B, 1981) [2]. Both ortracheal and nasotracheal tubes bypass natural defences, permit leakage of bacteria and secretions around the cuff into the trachea and reduce bacterial clearance from the trachea. The precise diagnosis of pneumonia in patients receiving mechanical ventilation is often difficult. Most of the patients have serious disease, increased oropharyngeal, colonization by hospital flora and numerous reactive elevated body temperature or leucocytosis (Johnson WG et al 1972 Artheratonat et al 1978, Rose HDet al 1975 , Charles s. Bryan et al 1984) [3, 1, 5, 6]. Purulent sputum may occur because of intubation or leakage of oropharyngeal secretions around the artificial airway. Furthermore, chest roentgenogram changes consistent with pneumonia may be caused by pulmonary oedema, pulmonary infraction, atelactasis are used as established criteria for the diagnosis of pneumonia, the clinical assessment of at least two independent investigators was considered necessary before diagnosing pneumonia, although we can include the possibility that pneumonias are incorrectly diagnosed, it is unlikely any true cases of pneumonia would have been missed by our criteria. The overall incidence of ventilator induced pneumonia in our study was 46%. Other studies have found pneumonia rates ranging from 21% to 66% (Cross and soup 1981, Craven et al 1986, F. Daschner et al 1987) [2, 7, 8].

Ventilators induced pneumonias are usually associated with some predisposing risk factors. Predisposing factor which were taken into account during this study were prior antacids, prior aspiration, alcoholism, smoking, prior hospital stay and underlying diseases which includes chronic lung disease, diabetes mellitus, neoplasia and heart insufficiency, antibiotic therapy, duration by Craven DE et al (1986), F. Daschner et al (1987) [7, 8]. Out of all the factors, mechanical ventilator associated pneumonia was more common in patients having prior aspiration (68.1%), alcoholism (50%), smoking (45%) craven et al (1986) [7] considered the raised intracranial pressure, cimetidine and antacids, fall-winter season as a significant variables for ventilator associated pneumonia. Their results may reflect severely ill patient at high risk for pneumonia rather than a direct causal relationship with pneumonia. When intracranial pressure increases, chest physiotherapy and frequent suctioning of pulmonary secretions are often avoided, special precautions are taken in neurosurgical patients, prevent repositioning of patient after surgery for CVjunction or high cervical cord.

Gastrointestinal bleeding in critically ill patients can be reduced by the use of antacids and cimetidine (Hasting pr et al 1978) [9]. Decreased gastric acidity increased gastric and tracheal colonization particularly when a gastric tube is in place (DUMoulin GC et al 1982, Atherton ST et al 1978 [10, 1], Hasting pr et al 1978) [9]. In our study, 42.3% patients given antacids or ranitidine developed pneumonia, which is reported to be 37% by craven et al 1986. Ranitidine causes overgrowth of bacteria in the stomach (DUMoulin et

al 1972, Atherton ST et al 1978) [10, 1], with tracheal colonization or may allow the host inflammatory and immune response decrease in the lung (Beer DJ et al 1984 [11].

This study does not support the previous data suggesting that mechanical ventilators circuits should be changed every 48 hour rather than every 24 hour as recommended by the centres for disease control 3, craven et al 1986 [7]. It was emphasized that ventilators without mainstream reservoir nebulizer impose no greater risk to a patient that imposed by breathing room air. Most mechanical ventilators have air that is moistened by cascade humidifier rather than by a reservoir nebulizer. The significant increase rate of pneumonia in patients having 24 hour ventilator circuit changes may have resulted from increased from increased manipulation of the patient, endotracheal tube or ventilator tube as suggested by Craven et al (1986) [7], but this was not seen in this study. They suggested the cause to bea probable contamination of the patients' airway by contaminated tubing condensate (Craven et al 1984) [12] or increased leakage of bacteria around the endotracheal tube into the trachea. Similarly the increased maniputlaion of other devices such as intravenous or bladder catheters may also increase nosocomial infection (Burke JP et al, 1981) [13]. In the present study, similar organisms were seen in the urine and tracheal aspirate in ten patients. This could have been due to transmission through nurses hands while manipulation urinary catheter following or preceding the suction procedures. Gram negative bacilli were frequently isolated from the sputum of patients with pneumonia as also seen by LAForce et al (1981) [14], Dashner et al 1988) [8], Craven et al (1986) [7], and Bryan et al (1984) [6]. Increased colonization of the pharynx with gram negative bacilli may be due to the severity of the patient's underlying disease or the use of drugs such as ranitidine. In the present study, the use of antibiotics was as associated with higher incidence of pneumonia. Antibiotics not only alter colonization in the oropharynx and gastrointestinal tract but also may have deleterious effects on the host immune response to infection (HanserWE et al 1982) [15].

However, the relationship between antibiotic use and nosocomial pneumonia is difficult to assess because of the wide spectrum of agents used alone or in combinaiton in the patient's population.

Use or respiratory filters (Lumley et al 1976, Hold croft et al 1973) [16, 17] in the inspiratory and expeiratory lines on the patient's side of the ventilator are used to prevent colonization of the ventilatory circuit by bacteria. Contamination of the lines between the patients and the filters was prevented by autoclaving the respiratory tubing every 24 hours and by filling humidifier reservoir with 0.02% chlorhexidine. A sterile technique used for tracheal suction, but rate of recovery of pseudomonas from tracheal aspirates was similar to that found before these measures were undertaken (Holdcraft et al 1973; Lumby et al 1976) [17, 16]. Suction of the tracheabronchialtree may lead to contamination of the trachea into the trachea during insertion of catheter.

In the present study, ventilatory circuit was decontaminated every 24 hour and reservoir fluid changed daily. However in 10 case contamination of reservoir fluid occurred. The contamination organism in 6 cases was the same as that isolated from tracheal secretions. Tracheal secretions were probably the source of reservoir contamination in these cases. Contamination could have taken place via contaminated tubing condensate or during manipulation.

Organisms are known to enter the mouth by various means, particularly in foods and fluids and during mouth washing (Johnson et al 1969 [3]. Mouth washing is always regarded as a sterile procedure and has been carried out with tap waters and cleaning pots contaminated with bacteria. Swallowed mouth secretions and nasogastric feed will introduce hospital acquired organisms into the stomach, where of antacids and H blockers are used, they will multiply. Consequently gastric regurgitation is another source of bacteria which may enter the respiratory passages by final common pathway of leakage around the endotracheal tube.

The recovery of organisms in the pharyngeal and tracheal secretions could also be explained by their deposition from contaminated hands in the mouth during oral hygiene and in the endotracheal tube during trachealsuction.

The danger of this route of spread can be reduced in various ways:

1. By preventing the entry of organisms into the mouth and stomach by providing sterile feeds and regular oral disinfection.

2. By avoiding the accumulation of secretions above the endotracheal tube cuff by nursing the patient in a head down position and keep the nasopharynx below trachea.
3. By removing such secretions via a small suction tube attached along the convex border of an endotracheal tube with its tip at the proximal end of the cuff.

Conclusions

Ventilators induced pneumonias are usually associated with some predisposing risk factors. Predisposing factor which were taken into account during this study were prior antacids, prior aspiration, alcoholism, smoking, prior hospital stay and underlying diseases which includes chronic lung disease, diabetes mellitus, neoplasia and heart insufficiency, antibiotic therapy Out of all the factors, mechanical ventilator associated pneumonia was more common in patients having prior aspiration (68.1%), alcoholism (50%), smoking (45%) craven et al (1986) considered the raised intracranial pressure, cimetidine and antacids, fall-winter season as a significant variables for ventilator associated pneumonia.

Swallowed mouth secretions and nasogastric feed will introduce hospital acquired organisms into the stomach .In Patients given antacids or histamine-2 blocker developed pneumonia more. Ventilators without mainstream reservoir nebulizer impose no greater risk to a patient for pneumonia. Our study does not support the previous data suggesting that mechanical ventilators circuits should be changed every 48 hour rather than every 24 hour as recommended by the centres for disease control. The danger of this route of spread can be reduced in various ways:

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