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Original Research Article

EVALUATING TRACHEAL ASPIRATES FOR MICROBIAL IDENTIFICATION, ANTIBIOTIC RESISTANCE ASSESSMENT, AND TREATMENT STRATEGIES IN VENTILATOR ASSOCIATED PNEUMONIA AT A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: For patients intubated in critical care units (ICUs), ventilator-associated pneumonia (VAP) is a serious health issue that raises death rates, length of hospital stay, and treatment expenses. Over the course of 12 months, the primary pathogens causing VAP at a tertiary care hospital in UP, India were examined in this study. Objectives: To ascertain the significance of routine pre-VAP endotracheal aspirate (EA) cultures in the effective management of ventilator-associated pneumonia (VAP) and the role colonizers play in the disease's etiology.
Material and Methods: During a 12-month period, a prospective observational cohort study was carried out. We looked at 230 individuals who had been on mechanical ventilation for more than 48 hours.
Results: 40 of the 230 patients who received mechanical ventilation during their ICU stay developed VAP. In patients on MV, the most frequent pathogens invading the respiratory tract were Acinetobacter spp. (52.5%) and Pseudomonas spp. (30.8%). The most frequent Gram-positive colonizer was Staphylococcus aureus (5%), of which 50% were methicillin-resistant S. aureus (MRSA). The other comparatively less frequent colonizers were Streptococcus pyogenes, Streptococcus pneumoniae, Enterococcus faecalis, and Candida spp.
Conclusion: In conclusion, quick care is essential due to the concerning link between VAP and bacteria that are resistant to many drugs. Determining the best suitable method for infection management requires identifying the key pathogens.
Keywords: critical care, ventilator-associated pneumonia, mechanical ventilation, Tracheal Aspirates, Resistance

INTRODUCTION

A nosocomial infection consequence known as ventilator-associated pneumonia (VAP) typically affects patients in intensive care units who are on mechanical ventilation for longer than 48 hours. It is linked to higher rates of morbidity and mortality, prolonged hospital stays, and higher treatment expenses. According to reports, the death rate linked to VAP is 27%, and in cases of antibiotic-resistant pathogens, it can rise to 43%. There have been reports of two distinct types of VAP, the late-onset VAP, which manifests more than 96 hours following intubation, and the early-onset VAP, which manifests 48–96 hours following intubation. The former is linked to enteric bacilli that are Gram negative and antibiotic-susceptible pathogens such as Haemophilus influenzae, Streptococcus pneumoniae, and Staphylococcus aureus. Antibiotic-resistant organisms such as methicillin-resistant S. aureus (MRSA), Pseudomonas aeruginosa, Acinetobacter

baumannii, and Stenotrophomonas maltophilia are known to cause the latter.

There are various reasons for the creation of VAP. The ventilator tracheal tube initially avoids the upper airway, which makes it easier for microorganisms to enter the lower airway and lessens the body's capacity to filter and humidify the air. The likelihood of microbial infection is further increased by the notable suppression of the cough reflex and the compromise of mucociliary clearance brought on by mucosal damage during intubation.

Additionally, endotracheal tubes facilitate the attachment of microorganisms to the trachea, which in turn promotes mucus production.

There is no "gold standard" for diagnosing VAP, hence the diagnosis is still debatable. The gold standard procedure, a lung biopsy, is not practical in a clinical context. In order to increase the specificity of diagnostic techniques, the American Thoracic Society (ATS) guidelines advise a quantitative distal lung sample obtained using either a bronchoscopic or non-bronchoscopic technique (Niederman MS, Craven DE., 2005). The necessity to distinguish between pathogenic germs and colonizing flora adds to the diagnostic challenge.

The global situation has become more complex due to the correlation between VAP and the multi-drug-resistant bacteria seen in intensive care units (ICUs). Therefore, it is essential to discover innovative antimicrobials to either prevent or treat the ensuing illnesses. Finding the primary causal agents and their resistance pattern is always the first step in accomplishing this. This will make it easier to select the most effective method for infection control from the range of antimicrobial strategies that are currently available, such as predatory bacteria, bacteriophages, and proteins derived from bacteriophages, as well as antimicrobial peptides (also known as bacteriocins) and enzymes (also known as enzybiotics), which the WHO has dubbed the post-antibiotic era (Nicastro J et al., 2016; Reuter M, Kruger DH (2020).

Determining the key pathogens responsible for VAP at a tertiary care hospital in UP, India. The various isolates will be tested for drug resistance patterns using a panel of several antibiotics from various classes.

MATERIALS AND METHODS

Media and cultural materials

HiMedia Laboratories Pvt. Ltd. (Mumbai, India) provided the blood agar and chocolate agar, the MacConkey agar, the Triple Sugar Iron (TSI) agar, the Simmon's Citrate agar, Peptone, yeast extract, NaCl and Brain Heart Infusion Broth etc, that were used in the laboratory.

Setting and subjects

A prospective observational cohort research was carried out at Hind Institute of Medical sciences in Barabanki, Uttar Pradesh, India in the department of microbiology, medicine, anesthesiology, and critical care over a 12-month period from Jan 2023 to Dec 2023. This study included all consecutive adult patients in the critical care unit (CCU) and medical intensive care unit (MICU) who were on mechanical ventilation (MV) for more than 48 hours. Individuals who had pneumonia 48 hours or earlier after MV were not included. The initial VAP event was the only one to be assessed. The patient's next of kin gave their informed consent, and the Institute's research and ethical committees approved the study.

ICU setting

Each intensive care unit has eight well-spaced beds with a partition separating them. An ICU with three nurses on duty and a nurse to patient ratio of 1:2.7 is in place. The other surfaces, such as the beds, trolleys, and window sills, are cleaned with ethanol three times a day, and the ICU floors are regularly washed with Lysol. The doctors were treating each patient individually while utilizing the ATS strategy, surveillance cultures, the existence of risk factors for MDR pathogens, their understanding of the local microbial flora in the ICU and their antibiograms.

Data collection

The study participants provided the following information: age, gender, underlying disease, length of hospital stay, length of mechanical breathing, and specifics of previous antibiotic medication. Additional pertinent information was gathered from radiography reports, bedside charts, medical records, and microbiological study results.

Inclusion criteria

This study included all patients (18 years of age and older) who were clinically suspected of having had ventilator-associated pneumonia (VAP) and were on mechanical ventilation for longer than 48 hours. The clinical pulmonary infection score (CPIS), which was assessed every day until the patient required ventilator assistance, was used to diagnose VAP. The diagnostic standard for VAP was a CPIS of more than six [Pugin J et al., 1991].

Exclusion criteria

All patients who were admitted with radiological and clinical indications suggestive of pneumonia.

Collection of endotracheal aspirates

Every time a patient in the MICU was suspected of developing VAP, an endotracheal aspirate (≥1 ml) was taken under aseptic precaution after 48 hours of intubation. A 22-inch Ramson's 12 F suction catheter with a mucus extractor was used to carefully insert the catheter—approximately 25–26 cm—through the endotracheal tube in order to collect the ETA. Each patient only had one ETA sample obtained, and that sample was sent straight away to the lab for analysis.

Microbiological processing

The study comprised aspirate specimens with Gram stain indicating <10 squamous epithelial cells per low power field or organisms observed under oil immersion throughout the field. Samples were homogenized by centrifuging at 3000 rpm for 10 minutes after being vortexed for 1 minute. The samples were then plated using a 4 mm Nichrome wire loop (Hi-media, Mumbai, India), which holds

0.01 ml of solution, on sheep blood agar (SBA), chocolate agar (CA), and MacConkey agar (MA). The plates were incubated at 37ºC for 18–24 hours. The threshold of 10^5 cfu/ml was used for quantitative cultures of ETA. Any organism growing below the cutoff was thought to be the result of contamination or colonization. Using the Kirby-Bauer disc diffusion method, organisms were discovered and the antimicrobial susceptibility tests of the following medications were ascertained: Hi-media Laboratories, Mumbai. Erythromycin (E) (15 µg), Clindamycin (Cd) (10 µg), Cotrimoxazole (CO) (25 µg), Cefazolin (Cz) (5 µg), Linezolid (Lz) (30 µg), Doxycycline (Do) (30 µg), Ciprofloxacin (Cip) (5 µg), Ceftazidime (Caz) (30 µg), Amikacin (Ak) (30 µg), Imipenem (I) (10 µg), Cefotaxime (Ce) (30 µg), Piperacillin-tazobactam (PiT) (100 µg/10 µg).

As quality control strains, Escherichia coli ATCC 25922 and Pseudomonas aeruginosa ATCC 27853 were employed.

Colonizers

In this study, colonizers were defined as bacteria that were isolated from the extrapulmonary fluid (EA) of mechanically ventilated patients at a concentration of less than 10^5 CFU/ml in both the VAP and non-VAP patients.

Evaluation of the pre-VAP EA strategy

If the bacteria were from the same species and exhibited comparable patterns of antibiotic susceptibility, they were deemed to be the same as those recovered from pre-VAP EA cultures and those found at a concentration of 10^5 CFU/ml in the quantitative EA culture obtained after VAP developed. We contrasted the ATS method with the antibiotic therapy that would have been recommended in accordance with the pre-VAP EA strategy.

RESULTS

In this investigation, 230 patients who had been on MV for more than 48 hours were prospectively monitored. Of these, 40 (17.39%) had VAP during their ICU hospitalization, according to the diagnosis. Of the 190 patients that were left, 19 of them had a difference between their quantitative EA culture and CPIS score. If the quantitative EA culture was negative in six situations, the CPIS was more than six. Due to abnormal chest X-rays from previous tuberculosis episodes, traumatic lung injuries, cardiopulmonary edema from underlying cardiovascular disease, temporary fever and leukocytosis after trauma or surgery, and/or poor oxygenation from underlying hemodynamic instability, the CPIS was deemed to be falsely high in these six patients.

Nevertheless, the CPIS was only temporarily high in all of these individuals, who were either afebrile or only mildly febrile. The majority of them recovered during the course of the following few days, eliminating the chance of VAP. Therefore, it was determined that these 5 patients did not have VAP.

Thirteen other instances had positive quantitative EA cultures, but their CPIS was less than six. Their chest X-rays were all normal, they were all afebrile, and the quantitative EA cultures that followed were negative. Aside from the VAP diagnosis, they also shown a swift improvement in their overall health without any interventions or adjustments to their antibiotic regimen. Therefore, they were not included in the VAP patient category.

The mean age of VAP patients in years was 39.2±15.6. In our analysis, there were 17 (42.5%) early-onset VAP cases and 23 (57.5%) late-onset instances. Table 1 provides a summary of the patients' demographic information who have VAP. Gram-negative bacteria accounted for 82.6% of the causal pathogens in the majority of VAP cases. The most frequent Gram-positive bacterial among VAP patients was Staphylococcus aureus, whereas the most prevalent Gram-negative bacteria were Acinetobacter baumannii and Pseudomonas aeruginosa. We looked at the percentage of VAP patients who possessed the critical MDR pathogen risk factors.

Of the 40 VAP patients, 29 (72.5%) spent five days or longer in the hospital, and 31 (77.5%) had received antimicrobial medication in the ninety-one days prior. Out of the 29 individuals without fertilization, 21 (72.4%) came from patients who had late-onset VAP, and 8 (20%) came from patients who had early-onset VAP. Nonetheless, risk indicators for MDR pathogens were present in all 8 early-onset VAP patients, from whom the non-fermenters were isolated.

Table 1: Demographic data for the 40 VAP patients

Characteristic	value
Age in yrs (mean±SD)	39.2±15.6
Gender Male female	 26(65) 14(35)
Underlying diseases Neuronal diseases Poisoning Abdominal diseases CNS infections CVD diseases Trauma Pregnancy related disorders	 12 11 7 3 3 2 2
Median time to occurrence of VAP	4days

Median no. of pre VAP EA cultures	1
Median delay between pre-VAP EA and onset of VAP	3 days

VAP-ventilator associated pneumonia; CNS-central nervous system; CVD-cardiovascular diseases

Colonizers of the respiratory tract in mechanically ventilated patients

In patients on MV, the most frequent pathogens invading the respiratory tract were Acinetobacter spp. (52.5%) and Pseudomonas spp. (30.8%). In 18% of the patients on mechanical ventilation, Enterobacteriaceae colonizers were found (Table 2).

The most frequent Gram-positive colonizer was Staphylococcus aureus (5%), of which 50% were methicillin-resistant S. aureus (MRSA). The other comparatively less frequent colonizers were Streptococcus pyogenes, Streptococcus pneumoniae, Enterococcus faecalis, and Candida spp. (non-albicans). [Table 2]

Table 2: Colonizers of mechanically ventilated patients

COLONIZER	No of isolates	Ciprofloxacin resistance (%)	Amikacin resistance (%)	Ceftazidime resistance (%)	Meropenem resistance (%)
Gram –ve bacteria/Non fermenters					
Acinetobacter baumannii	52	93	84	95	43
Acetinobacter lwoffii	12	90	91	90	37
Pseudomonas aeruginosa	45	63	41	56	7
Pseudomonas spp	10	68	76	55	15
Enterobacteriaceae					
Escherichia coli	19	22	93	92	0
Klebsiella pneumoniae	17	21	77	66	7
Citrobacter diversus	5	5	98	99	2
Enterobacter spp	2	1	97	55	1
Providencia spp	1	3	99	98	0
Proteus spp	8	1	62	100	0
Gram +ve bacteria					
MSSA	7	8	17	-	-
MRSA	1	9	89	-	-
Streptococcus pyogenes	2	1	-	-	-
Streptococcus pneumonaie	1	2	-	-	-
Enterococcus faecalis	1	2	-	-	-

Mssa- methicillin-susceptible staphylococcus aureus; mrsa- methicillin-resistant staphylococcus aureus

Important VAP pathogen colonization rates

Pre-VAP EA cultures were not possible since 15 patients developed VAP as early as day 2 to 4 of mechanical breathing. Of the 25 VAP cases that remained, pre-VAP EA cultures were conducted. In 16 out of the 25 (64.0%) assessable VAP cases, colonization was found. Before developing into VAP, many of the pathogenic bacteria responsible for VAP were first found in the respiratory system as colonizers. Compared to Enterobacteriaceae, colonization rates were comparatively greater with non-fermenter and MRSA. [Figure 1]

Table 3: Microorganisms isolated & correlated with chest x-ray

organisms	No. of isolates	Left side no.(%)	Right side no.(%)	Bilateral no.(%)
Acinetobacter baumannii	21	4(19.04)	7(33.33)	10(47.61)
Acinetobacter species	1	0	1(100)	0
Pseudomonas aeruginosa	12	1(8.33)	4(33.33)	7(58.33)
Klebsiella pneumoniae	2	1(50)	1(50)	0
Escherichia Coli	1	1(100)	0	0
Citrobacter freundii	1	0	1(100)	0
Staphylococcus aureus	2	1(50)	1(50)	0
Total	40	7	15	17

Comparison of routine serial EA cultures (pre-VAP) and quantitative culture of EA obtained after the development of VAP

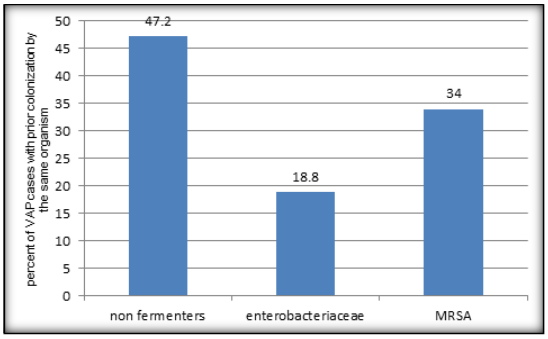

Figure 1: Comparison of the colonization rates of important VAP pathogens

Previous colonization's diagnostic usefulness in predicting VAP

Table 3 summarizes the diagnostic usefulness of prior colonization by several pathogens in predicting the subsequent VAP induced by these microorganisms in terms of sensitivity, specificity, and predictive values.

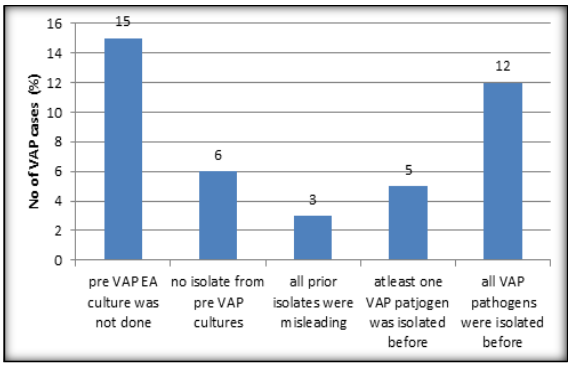

Figure 2: Role of routine serial cultures in predicting VAP pathogens

Antimicrobial therapy's appropriateness in comparison to the ATS strategy based on pre-VAP EA cultures.

We were unable to use the pre-VAP EA culture-based approach to those 25 patients since pre-VAP EA cultures were not carried out in 17 VAP cases due to the previously listed reasons, and in six additional cases the EA cultures were sterile. Therefore, we only assessed the pre-VAP EA strategy and the ATS strategy in the 12 assessable VAP instances that were still open. In accordance with ATS guidelines, 7 out of the 12 assessable VAP cases (58%; 95% confidence interval (CI) 32–80%) would have benefited from antibiotic treatment if they had followed a piperacillin–tazobactam and aminoglycoside regimen, or from a carbapenem–aminoglycoside regimen.

Acinetobacter spp. and Pseudomonas spp., which are resistant to even the higher antibiotics like meropenem, piperacillin–tazobactam, ceftazidime, gatifloxacin, and amikacin, which are recommended by the ATS for the treatment of MDR pathogens, were present in most of the cases in which the ATS strategy would have failed. Four (33%) and 9 (75%) of the 14 Acinetobacter spp. that were identified from VAP patients were resistant to piperacillin-tazobactam and meropenem, respectively. In a similar vein, 3 (25%) and 5 (41%) of the 13 Pseudomonas species were resistant to piperacillin-tazobactam and meropenem, respectively.

DISCUSSION

VAP, or ventilator-associated pneumonia, is a frequent yet dangerous side effect in patients receiving mechanical breathing. To enhance patient outcomes and lower death rates, it is imperative to identify and treat VAP as soon as possible. Tracheal aspirates are important tools for assessing the bacterial cause of VAP and identifying patterns of antibiotic resistance that can help choose the best course of treatment. In order to identify bacteria, determine antibiotic resistance, and make treatment decisions, it is critical to assess tracheal aspirates in VAP. A sizable fraction of the patients in our study experienced early-onset VAP. Even in a sizable US-based study with 842 VAP cases, over 63% of patients experienced VAP 48 hours after MV (Rello J et al., 2002; Al Zahraa M. Maebed et al., 2021). These patients are more vulnerable because of the confluence of multiple risk factors in the early stages of MV. Furthermore, since our hospital is a tertiary care facility, the majority of our patients would have sought treatment at multiple primary care facilities prior to coming to us. As a result, they were likely already colonized with multiple pathogens, which may have contributed to the early occurrence of VAP. Pseudomonas spp. and Acinetobacter spp. were found to be the most frequent pathogens populating the respiratory tracts of the patients receiving MV. Fifty percent of the S. aureus colonies found in the respiratory tract were MRSA. Acinetobacter species, Pseudomonas species, and MRSA can colonize the respiratory tract from endogenous sources like the stomach or oropharynx, or from exogenous sources like contaminated respiratory instruments, infectious aerosols from the intensive care unit, and contaminated hands and clothing of healthcare personnel.

In the event that VAP occurs, these non-fermenters and MRSA, sometimes known as "MDR" bacteria, are more challenging to treat due to their high levels of antibiotic resistance. (Niederman MS, Craven DE., 2005; Trouillet JL et al., 1998). The high rate of colonization by MDR pathogens is explained by the fact that most of our VAP patients had risk factors for these infections. We discovered that in assessable cases of VAP, colonization came before infection of the lower airways based on repeated evaluation of colonization and infection using EA. By doing routine quantitative cultures of surveillance EA samples, we were able to correctly and prospectively ascertain the sequence and incidence of lower respiratory tract infection to colonization in patients on maintenance ventilation.

Of the bacteria that cause VAP, 47.2% of non-fermenters and 34% of MRSA were initially found in the respiratory tract as colonizers before developing into VAP. So, these organisms' colonization may make a person more susceptible to VAP.

The study conducted by Hayon et al. highlighted the limitations of serial culture, as all the organisms eventually accountable for VAP were previously collected from only 35% of the respiratory secretions. (Hayon J, et al., 2002). Only 21 (10%), 17 (8%), 8 (4%), and 7 (3%) of the 220 bacteria implicated for VAP were recovered from catheter tips, routine surveillance cultures (nasal, throat, and skin swabs), urine, and blood, respectively, according to the aforementioned study (Hayon J, et al., 2002).

In contrast, bronchoalveolar lavage (BAL) results and pre-VAP EA culture results agreed in 72% of patients in a research by Jung et al. (Jung B, et al., 2009). Similarly, in 83% of the VAP cases in a study by Michel et al., pre-VAP EA had found the same microbes (with the same patterns of antibiotic resistance).

The limited recovery of VAP pathogens in our investigation was caused by the increasing number of early-onset patients, for which there were either few or no pre-VAP EA specimens available. Another explanation for the reduced recovery of VAP pathogens in pre-VAP EA may be because the majority of our patients received broad-spectrum antibiotics at an early age.

The sensitivity of tracheal surveillance cultures to predict MDR VAP bacteria was 69% in a research by Depuydt et al.2008

While the pre-VAP EA culture in our study had a comparatively low sensitivity of 45% to predict A. baumannii, its sensitivity of 70% to predict P. aeruginosa is equivalent to that of the study by Depuydt et al.2008. Prior colonization by P. aeruginosa, A. baumannii, and MRSA had a high negative predictive value (80–94%) and very good specificity (96–100%), which allowed it to accurately rule out the majority of patients who were not infected by these MDR pathogens; however, because of their low sensitivity (33–70%), failure to recover these organisms does.

Antibiotic(s) administered to VAP patients in accordance with various protocols

antibiotic(s) How many patients would be given a specific antibiotic or antibiotics based on:

ATS strategy and Pre-VAP EA strategy Ceftriaxone, Ceftazidime, Amikacin + meropenem, Erythromycin + Amikacin, Meropenem, Penicillin + Ticarcillin, Vancomycin, Piperacillin–Tazobactam + Amikacin, Levofloxacin + Meropenem + Cefoperazone - sulbactam, Colistin + Rifampin + meropenem. Although another recent study also indicated that the specificity of these pathogens was high, (Lampati L et al., 2009) there are no data to support antibiotic therapy of these invaders to prevent VAP.

On the other hand, antibiotic therapy of ventilator-associated tracheobronchitis (VAT) has been definitively shown to be associated with a decrease in the number of days of mechanical ventilation (MV) as well as a decrease in the rates of ventilator-associated pneumonia (VAP). (Nseir S, et al., 2005). According to Craven et al.'s clinical judgment, targeted antibiotic therapy for VAT could provide a novel approach to the prevention of VAP. (Craven DE et al.,2009). Microorganisms other than P. aeruginosa, A. baumannii, and MRSA that colonized an area exhibited extremely low likelihood ratios, PPV, NPV, sensitivity, and specificity. Therefore, colonization by these organisms will not be helpful in forecasting when these organisms may go on to cause VAP. Treatment based on the pre-VAP EA culture results was ineffective in directing empirical antibiotic therapy in the majority (55.6%) of the VAP cases because the pre-VAP specimens were either sterile. It was not possible to gather pre-VAP EA specimens. On the other hand, 81% of the time, if one or more microorganisms were recovered from the pre-VAP EA specimens, the treatment was suitable. Additionally, studies by Michel et al. have demonstrated that routine EA carried out twice a week is helpful in recommending appropriate antibiotic therapy in 95% of patients in whom a BAL culture ultimately results in a VAP diagnosis. (Michel F et al., 2005). The treating physician must wait a full day or two to receive the antibiotic sensitivity profiles and EA or BAL quantitative culture results. The ATS guidelines recommend treating patients who have risk factors for MDR microorganisms with a combination of anti-pseudomonal cephalosporin, carbapenem, or b-lactam/b-lactamase inhibitor and anti-pseudomonal fluoroquinolone, either with or without vancomycin.[4] ATS-recommended empirical regimen, however, could not work against MDR P. aeruginosa and MDR A. baumannii, which are resistant to piperacillin-tazobactam and carbapenem. Our research shown that even while pre VAP cultures were not accessible in most of our cases, if they were, this may direct therapy that was more appropriate than the ATS approach. Thus, awareness of the doctor may be guided in treating potentially multidrug-resistant (MDR) infections appropriately by the susceptibility pattern of the isolates from pre-VAP EA cultures. It has been suggested that colistin, polymyxin, and tigecycline combination regimens are effective in treating these infections. (Maragakis LL, Perl TM., 2008; Leung CH, et al., 2008). Additionally, the PPV of MDR organisms isolated from pre-VAP EA cultures, such as P. aeruginosa, A. baumannii, and MRSA, in predicting the VAP pathogens was high enough to support broadening the initial antibiotic therapy's scope to address these MDR pathogens. Therefore, in light of our findings, we recommend that VAP patients receive standard care in accordance with the ATS approach, but that whenever the aforementioned MDR When pathogens are isolated from pre-VAP EA cultures, treatment with antibiotics should be continued. This change will be especially helpful in environments like ours where MDR infections that do not respond to standard stronger antibiotics are common. The recommended course of treatment for MDR Acinetobacter spp. resistant to meropenem is intravenous colistin plus rifampin, either with or without imipenem or tigecycline. (Maragakis LL, Perl TM. 2008). Similar to this, colistin or levofloxacin combined with piperacillin-tazobactam is the recommended treatment for MDR P. aeruginosa resistant to meropenem. using ceftazidime/cefoperazone combined with sulbactum, or imipenem (Leung CH, et al., 2008; Lister PD, et al., 2006). MDR species isolated from surveillance cultures, including P. aeruginosa, A. baumannii, and MRSA, showed poor positive predictive values of 62%, 52%, and 24%, according to Hayon et al. correspondingly, in forecasting the occurrence of VAP caused by these infections. (Hayon J, et al., 2002). Therefore, it seems that many patients were given needless broad-spectrum antibiotics as part of the monitoring culture-based treatment. However, we discovered that MRSA, P. aeruginosa, and A. baumannii isolated from pre-VAP EA cultures

showed strong positive predictive values of 100%, 88%, and 83%, respectively, in our ICUs with a rather high frequency of these MDR pathogens.

The primary limitation of our study was the small number of individuals with VAP that were examined due to the resource-constrained nature of the research environment. The few infections resulted in extremely big 95% confidence interval for forecast values, which reduces the accuracy of the findings. Larger clinical studies are therefore required to corroborate the findings of our investigation, as this could have a significant effect on the management of VAP, a difficult condition for critical care physicians, particularly in poor nations. Our study's second weakness is that, in order to confirm VAP, we did not do quantitative culture on bronchoscopically obtained samples, such as BAL.

CONCLUSION

It is critical to assess tracheal aspirates in VAP for antibiotic resistance, bacterial diagnosis, and therapy options. It helps medical professionals to precisely diagnose the causing infections, evaluate the patterns of antibiotic resistance in those pathogens, and decide on the best course of action. This methodology enhances patient outcomes, lowers mortality rates, and maximizes the use of antibiotics. Subsequent investigations ought to concentrate on improving methods for identifying bacteria and determining the susceptibility of antimicrobial agents to them, along with investigating the possibilities of innovative diagnostic approaches to improve the handling of VAP.

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