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Assessment of Efficiency of Using Clinical Pulmonary Infection Score (CPIS) Among Mechanically Ventilated Cases

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Abstract: Ventilator-Associated Pneumonia (VAP) is a common Healthcare Associated Infection (HAI) in critical care department;VAP occurs frequently and is associated with significant morbidity and mortality in critically ill patients. This study aimed to improve health outcome of patients on Mechanical Ventilation (MV) through early diagnosis of (VAP), early management with appropriate antibiotics prescription using Clinical Pulmonary Infection Score (CPIS). Operational research, quasi-experimental interventional study design. The study was conducted in the in critical care department in the Faculty of Medicine Cairo-University. The study has 2 phases; Phase 1: recruiting the control group (40 cases) on MV not using CPIS. Phase 2: recruiting the interventional group (40 cases) on MV using CPIS. The CPIS at day 1 was calculated based on first five variables which are temperature, blood leukocyte count, tracheal secretions, oxygenation and character of pulmonary infiltrate in the X-ray. At day 3 of MV the CPIS was calculated based on all seven variables and took into consideration the progression of the infiltrate in chest X-ray and culture results of the tracheal aspirate, a score >6 at baseline or at 72 h is considered suggestive of pneumonia. If < = 6 at 72 h patient probably doesn't have pneumonia and antibiotics probably can be stopped. Most of the cases were admitted in both groups due to Cardiovascular diseases CVS and neurological diseases CNS and the most common cause of ventilation was Disturbed Conscious Level DCL followed by post arrest cases. The most common organism in control group was *Klebsiella* 25% and in intervention group was MRSA 17.5%. The CPIS was lower in intervention group at the day 3 with significant difference p = 0.01. Deathsin intervention group (who were followed by CPIS) were insignificantly lower. The median of total cost and medication cost were lower in intervention group and themedian of antibiotic cost was significantly lower in patients (who were followed by CPIS) in intervention group than control group p = 0.01. CPIS considered tool to monitor patient's condition on MV and monitor their response to antibiotic treatment for early modification which in turn reflected on hospital stay and cost.

Key words: Mechanical Ventilation MV, Ventilator Associated Pneumonia VAP, Intensive Care Unit ICU, Clinical Pulmonary Infection Score CPIS, Acute Physiology and Chronic Health Evaluation APACHE and cost, management

INTRODUCTION

ICU patients are more vulnerable to health care associated infection HAIs due to complexity and number of interventions (Hemmila and Wahl, 2016). HAIs are associated with prolonged hospital stays, greater health care costs and increased mortality (EL-Kholy *et al*., 2012). Reducing the risk of HAIs is one of international patient safety goal (Anonymous, 2016) and better evaluation of the costs of these infections could help providers and payers to justify investing in prevention of the HAIs (Zimlichman *et al*., 2013).

VAP is one of HAIs and is defined as pneumonia that develops more than 48 h after tracheal intubation or tracheotomy. The challenges of managing VAP include the requirement for appropriate antimicrobial therapy and the need to avoid administering of unnecessary antibiotics (Iregui *et al*., 2002).

Inappropriate use of antibiotic leads to the threat of antimicrobial resistant organismsand it is a growing concern worldwide with difficulties experienced in treating those (Hamdy *et al*., 2014).

It has been well documented that initial antibiotic treatment should be active against likely pathogens and it's choice should be based on prior antibiotic exposure,

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patient comorbidities, length of hospitalization and special consideration to the Multidrug Resistant (MDR) pathogens (Piskin *et al*., 2012).

As well as the Major Determinant of the Risk of MDR pathogens causing VAP was previous antibiotic selection pressure (exposure to more than two different classes of antibiotics, since, hospital admission) and degree of organ failure before diagnosis of VAP (Depuydt *et al*., 2008).

The Clinical Pulmonary Infection Score (CPIS) was proposed in 1991 as a diagnostic method for Ventilator Associated Pneumonia (VAP) and has also been studied as a tool for reducing unnecessary antibiotic use in critically ill patients (Fartoukh *et al*., 2003; Pugin *et al*., 1991) and (Singh *et al*., 2000).

The modified CPIS at baseline is assessed on the basis of five variables which are temperature, blood leukocyte count, tracheal secretions, oxygenatio and character of pulmonary infiltrate. CPIS at 72 h is calculated based on all seven variables and took into consideration the progression of the infiltrate and culture results of the tracheal aspirate. A score >6 at baseline or at 72 h is considered suggestive of pneumonia. If < = 6 at 72 h patient probably doesn't have pneumonia and antibiotics probably can be stopped (Singh *et al*., 2000).

The study objectives are assessment of mortality rate from Ventilator Associated Pneumonia (VAP) in the studied group, early detection of cases of (VAP) using Clinical Pulmonary Infection Score (CPIS) and measurement of cost efficiency of using CPIS for patients with VAP as regards duration and cost of hospital stay and cost of the antimicrobial therapy.

MATERIAL AND METHODS

Setting and design: Operational research, quasi experimental interventional study design. The study was conducted in the in critical care department in the Faculty of Medicine Cairo-University. One of the multidisciplinary major referral system for critical care patients, serving patients referred from the hospital and from outside.

Sample size and target population: All patients (convenient sample) admitted to the critical care department and underwent intubation and mechanical ventilation according to, inclusion and exclusion criteria were included during the period of the study. Inclusion criteria were: patients admitted to the critical care department and received mechanical ventilation. Patients enter the study after agreement of the staff. Exclusion criterion was patients diagnosed pneumonia before ventilation.

Data collection: Data were collected in 2 phases and we use the APACHE II scoring system for detection of clinical condition of MV patients within 24 h from admission and predict the mortality rate of them, this score will affect the patient's outcome together with the associated comorbidities.

Phase 1: Control group not using CPIS, each MV patient was visited in day 1of MV, day 3 of MV and then every day till the day of extubation to collect clinical, laboratory, microbiological and radiological data.

Phase 2: Intervention group using CPIS. Same as phase 1 and the staff was trying to use CPIS. At day 1 the CPIS was calculated based on first five variables which are temperature, blood leukocyte count, tracheal secretions, oxygenation and character of pulmonary infiltrate in the X-ray. At day 3 of MV the CPIS was calculated based on all seven variables and took into consideration the progression of the infiltrate in chest X-ray and culture results of the tracheal aspirate, a score >6 at baseline or at 72 h is considered suggestive of pneumonia. If < = 6 at 72 h patient probably doesn't have pneumonia and antibiotics probably can be stopped.

Source of data: Hospital Information System (HIS) Medicapluse 4 Software-from the Information Technology Department (IT). Patient's files: the patient's medical records at bed site. Pilot study was done and Statistical Package for Social Science (SPSS Version 17) was used for analysis.

Ethical approval: The head of the critical care department agreed the study protocol, the written approval was taken and patient confidentiality was protected by codifying the recorded information, making it identifiable. Approval of the study from the scientific research committee of the department and that of the faculty was taken.

RESULTS AND DISCUSSION

The two groups were homogenous as there was no significant differencebetween both groups regarding age, clinical condition on admission which was assessed by APACHE II score. In control group the median of the age was 65 (min 13, max 90) and in intervention group the median of the age was 62 (min 24, max 86). The median of APACHE II score in control group was 20.5 (min 6, max 33) and in intervention group was 18 (min 6, max 35) the p value was 0.7 and 0.2, respectively.

There was no significant difference between both group regarding causes of patient admission and causes of ventilation as most common causes of admission were CVS and CNS causes p-value was 0.09. The causes of ventilation were DCL and post arrest in both groups. The p-value was 0.5.

We found that the most common organism in the culture results in our study was the gram-ve organism *Klebsiella* (25%) in control group versus gram+ve organism MRSA in intervention group (17.5%).

The line graph shows the changes of the median of CPIS score over time of ICU stay in both groups. At day 1of MV the median of CPIS was equal in both groups the score was 3 with no significant difference p = 0.07, at day 3of MV the median of CPIS of control group increased rapidlyand it was significantly higher in control group than intervention group the score (6 Versus 4), respectively, p = 0.01.

In intervention group the CPIS course showed slight increase but it remain lower than control group and below 6. At the day of extubation the median of CPIS is insignificantly lower in intervention groupthan control group score (5 Versus 6), respectively, p = 0.62.

When we go throw intervention group we found that 19 cases (47.5%) were followed by CPIS and 21cases (52.5%) weren't followed by CPIS due to the opinion of the ICU staff who were not familiar with using CPIS in MV patients and they recommend to start the antibiotics immediately to the patients once the ventilation started. Moreover 33% of the cases who weren't followed by CPIS suspected to have MRSA due to history of MDR and they start antibiotics immediately and didn't follow the CPIS.

The table shows that the total and medication cost were lower in intervention group (who followed by CPIS) than control group with no significant difference.The antibiotic cost was significantly lower in patients who were followed by the CPIS in intervention group also, the number of antibiotics taken was lower in intervention group who were followed by CPIS than control group with no significant difference.

We found positive weak correlation between CPIS at day 3 of MV with the number of antibiotics taken with no significant difference between two groups (r = 0.2, p = 0.03), the deaths in intervention group (who were followed by CPIS n = 19) were insignificantly lower than those in control group (n = 40) 58 Versus 60%, respectively, p = 0.57 which suggest that the patient's outcome was affect by the age and the underlying morbidity and comorbidities. The table shows that the APACHE II score was significant risk factor for patient deat as each unit increase in APACHE II score increase risk of death by 5%.

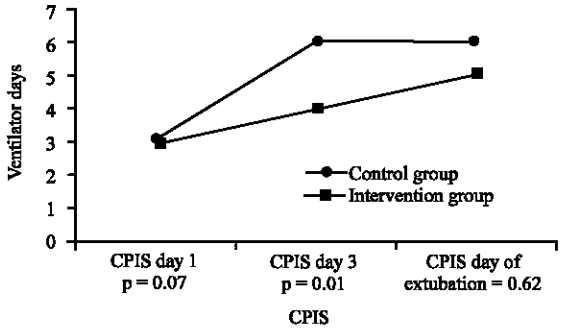

Fig. 1: Line graph of the median of the CPIS in the day 1 of ventilation, day 3 and day of extubation in control group n = 40 and intervention group n = 40

Pugin and his colleague reported that CPIS >6 was associated with a sensitivity of 93% and a specificity 100% for diagnosis the pneumonia. More recent meta-analysis study was conducted and provided that CPIS may give suggestive evidence but not definitive evidence that VAP is either present or absent (Klompas, 2007; Pugin *et al*., 1991).

The CPIS has been most successfully used in guiding treatment decisions for patients with VAP and resulted in lower costs and reduced development of antimicrobial resistance (Zilberberg and Shorr, 2010).

Moreover Harde and his colleague found that the CPIS is a reasonable tool to early detection of VAP and initiation of appropriate broad spectrum empiric therapy with de-escalation when cultures are available can reduce the morbidity, mortality and antibiotic overuse (Harde *et al*., 2013).

In our study the data of CPIS was collected on day 1 and 3 at the day of extubation, the datawas taken from the patient's medical record and data of the patients from the Hospital Information System (HIS) (medicapluse) for control group and intervention group then calculated.

At day 1of MV the median of CPIS was equal in both groups with no significant difference p = 0.07, at day 3of MV the median of CPIS of control group was significantly higher than intervention groupdespite of starting antibiotics empirically from day 1 in control group and the score remain stationary till the day of extubationwhich showed their response to the medication. In intervention group the CPIS course showed slight increase but it remain lower than control group and below 6.

At the day of extubation the median of CPIS is insignificantly lower in intervention group than control group score (5 Versus 6), respectively, p = 0.62 as present in (Fig. 1).

Table 1: Comparison between patients in control group and intervention group (who were followed by CPIS), regarding total, medication and antibiotic cost by Egyptian pounds (LE)

Items	Control group n = 40	Intervention group (Patients were followed by CPIS) n = 19	p-values
Total cost			
Median	15.658	11.400	
Minimum	2540	2870	0.22
Maximum	66.160	85.300	
Medication cost			
Median	7011	4600	
Minimum	845	450	0.21
Maximum	38.584	61.300	
Antibiotic cost			
Median	3350	2270	
Minimum	146	108	0.01
Maximum	29.506	28.000	
Number of antibiotics			
Median	3	2	
Minimum	2	1	0.07
Maximum	7	5	

Similar findings were founded in retrospective cohort study at 31critical care units across France. The CPIS was determined on days 1 and 3 and compared in patients identified as having developed VAP or not. At the day 1 the mean of CPIS were similar for the two groups (6.4 Versus 6.2). However, when the CPIS was calculated on day 3, the mean CPIS was higher for patients with VAP (8.7±1.8) than those without (7.0±1.9) ($p < 0.0001$) (Luyt *et al*., 2004).

Other study was agreed with our results, the study was conducted on Alexandria University to explain that CPIS 6 or higher suggest pneumonia and CPIS <6 indicate low probability of pneumonia in VAP patients and also for Community Acquired Pneumonia (CAP)(Foud *et al*., 2008).

More over when comparing the control group (not using the CPIS) with those in intervention group (who were followed by CPIS) we found that the median of antibiotic cost was significantly lower in patients (who were followed by CPIS) in intervention group than control group (2270 Versus 3350 LE) $p = 0.01$ as present in (Table 1).

On the other hand due to the high age of the patients and underlying medical conditions there was no significant difference in median of total cost and medication cost between the 2 groups but it is lower in the intervention group(who were followed by CPIS) than the control group (not using CPIS) $p = 0.22, 0.21$, respectively. The number of antibiotics taken was affected by opinion of the staff but was still lower in intervention group (who were followed by CPIS) than those in control group (not using CPIS) 2 Versus 3, respectively with insignificant difference $p = 0.07$ as present in (Table 1).

Table 2: The table displays logistic regression between patient outcome and factors affecting it in control group n = 40 and intervention group n = 40

Factors affecting patient outcome	Odd ratio	Confidence intervalCI 95% Lower limit	Upper limit	p-values
Age	1.01	0.97	1.04	0.68
Sex	1.33	0.34	3.48	0.54
APACHE II score	1.05	0.97	1.16	0.02*
Charlson score	0.94	0.73	1.20	0.62
Ventilator days	0.98	0.95	1.02	0.55
Using of CPIS	0.65	0.25	1.68	0.41

*Significant value

Logistic regression was done in our study to determine the risk factors for patient's mortality and we found that the APACHE II score was significant risk factor for patient death in MV patients and using CPIS score was not risk for patient death among MV patients, it was used to monitor the VAP condition, change antibiotic according to the patient's response which prevent over use of antibiotics, decrease the cost and avoid developing of drug resistant organism as present in (Table 2).

Other study revealed different results as they found in themultiple logistic regression analysis that the delay in appropriate antibiotic treatment after VAP diagnosis, APACHE II scores and the presence of underlying malignancy were important determinants of hospital mortality of MV patients (Iregui *et al*., 2002).

CONCLUSION

The critical care department admit cases from the hospital wards and from outside. The CPIS was significantly lower at day 3 of MV in intervention group and it remains below 6 at the day of extubation which suggests close monitoring of the VAP patients with proper antibiotic control.

Theempirical prescription of antibiotics for the patients in our study was founded to be mainly attributed to the physician's attitude of lacking the knowledge of the CPIS. Also in spite of infection control measures which were taken, the staff recommends to start antibiotics from the first day of ventilation, especially with continuous availability of intravenous line of the patients facilitating the introduction of systemic antibiotics.

Mortality among MV patients was not affected by using the score, the score gives an image for VAP patients and their response to the treatment for proper management. Now, the IT Department is working on the CPIS score to be established in the HIS of the department to use it as a tool to monitor the patients on MV and guide the treatment decision of them.

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