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Assessment of Efficiency of Using Clinical Pulmonary Infection Score (CPIS) on the Outcome and Cost of Mechanically Ventilated Cases

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Abstract

Background: 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.

Aim of Study: 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) and measurement the cost of hospital stay and cost of the antimicrobial therapy.

Methods: 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.

Results: The CPIS was lower in intervention group at the day 3 with significant difference p=0.01. Deaths in intervention group (who were followed by CPIS) were insignificantly lower. The median of total cost and medication cost were lower in intervention group and the median of antibiotic cost was significantly lower in patients (who were followed by CPIS) in intervention group than control group p=0.01.

Conclusion: 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 – Cost.*

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Introduction

ICU patients are more vulnerable to health care associated infection HAIs due to complexity and number of interventions **[1]**. HAIs are associated with prolonged hospital stays, greater health care costs, and increased mortality **[2]**. Reducing the risk of HAIs is one of international patient safety goal **[3]** and better evaluation of the costs of these infections could help providers and payers to justify investing in prevention of the HAIs **[4]**.

VAP is one of HAIs and is defined as pneumonia that develops more than 48 hours 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 **[5]**.

Inappropriate use of antibiotic leads to the threat of antimicrobial resistant organisms and it is a growing concern worldwide with difficulties experienced in treating those **[6]**.

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, patient co-morbidities, length of hospitalization and special consideration to the Multidrug Resistant (MDR) pathogens **[7]**.

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 **[8]**.

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 [9,10].

The modified CPIS at baseline is assessed on the basis of five variables which are temperature, blood leukocyte count, tracheal secretions, oxygenation, and character of pulmonary infiltrate. CPIS at 72h 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 72h is considered suggestive of pneumonia. If <6 at 72 hours patient probably doesn't have pneumonia and antibiotics probably can be stopped [11].

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 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 from May 2012 to January 2014. 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:

1- Patients admitted to the Critical Care Department and received mechanical ventilation.

2- Patients enter the study after agreement of the staff. Exclusion criterion was patients diagnosed pneumonia before ventilation.

Data collection: Data were collected from the patient's medical records admitted in Critical Care Department in 2 phases. We use the APACHE II scoring system for detection of clinical condition of MV patients within 24 hours 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 1 of MV, day 3 of MV and then every day till the day of extubation to collect clinical, laboratory, microbiological and radiological data and patient outcome at the day of extubation.

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 72h is considered suggestive of pneumonia. If <6 at 72 hours patient probably doesn't have pneumonia and antibiotics probably can be stopped. Also CPIS was calculated at the day of extubation to assess patient outcome.

Cost calculation: Direct cost which is related to the patient care and hospitalization. Total cost include: (50 L.E) bed stay per day, medications, labs, radiology, procedures as ECG and CVP, 10% consumables, (15 L.E) per day computer services and administrative services and (40 L.E) per day ventilator stay).

Source of data:

1- Hospital Information System (HIS)-Medica pluse 4 software-from the Information Technology Department (IT).

2- 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

The two groups were homogenous as there was no significant difference between both groups regarding age, clinical condition on admission which was assessed by APACHE II score.

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.

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%).

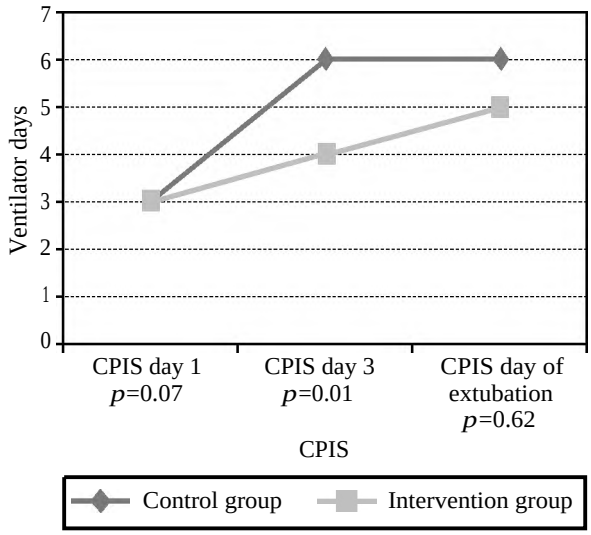

Fig. (1): Line graph of the median of the CPIS in the day 1 of ventilation, day 3 and day of extubation in control group n=40 and intervention group n=40.

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-value
Total cost:			
Median	15,658	11,400	0.22
Minimum	2540	2870	
Maximum	66,160	85,300	
Medication cost:			
Median	7011	4600	0.21
Minimum	845	450	
Maximum	38,584	61,300	
Antibiotic cost:			
Median	3350	2270	0.01
Minimum	146	108	
Maximum	29,506	28,000	
Number of antibiotics:			
Median	3	2	0.07
Minimum	2	1	
Maximum	7	5	

The table shows that the median of total and medication cost were insignificantly lower in intervention group (who followed by CPIS). The antibiotic cost was significantly lower in patients who were followed by the CPIS in intervention group.

The current study showed weak significant positive correlation between CPIS at day 3 of MV with the number of antibiotics taken (r=0.2, p= 0.03), with no significant difference between two groups.

Table (2): Comparison between patients in control group and in intervention group (who were followed by CPIS), regarding patient outcome.

	Control Group n=40 N (%)	Intervention Group (patients were followed by CPIS) n=19 N (%)	p-value
• Death (n=35)	24 (60%)	11 (58%)	0.57
• Recovered/referred (n=24)	16 (40%)	8 (42%)	

The table shows that there was no significant difference between both groups regarding the patient outcome. The deaths were more in control group.

Table (3): 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 interval CI 95%		p-value
		Lower limit	Upper limit	
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

The table shows that the APACHE II score was significant risk factor for patient death, as each unit increase in APACHE II score increase risk of death by 5%.

Discussion

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 **[12]**.

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 [13].

More over 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 [14].

In the current study the data of CPIS was collected on day 1, day 3 and at the day of extubation, at day 1 of MV the median of CPIS was equal in both groups with no significant difference p=0.07, at day 3 of MV the median of CPIS of control group was significantly higher than intervention group despite of starting antibiotics empirically from day 1 in control group and the score remain stationary till the day of extubation which 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 p=0.62 as in Fig. (1).

Similar findings were founded in retrospective cohort study at 31 Critical 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 day1 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) ($p<0.0001$) [15].

Other study was agreed with the study results, the study was conducted on Alexandria University to explain that CPIS 6 or higher suggest pneumonia and CPIS less than 6 indicate low probability of pneumonia in VAP patients and also for Community Acquired Pneumonia (CAP) [16].

When the researcher go throw intervention group he found that 19 cases (47.5%) were followed by CPIS and 21 cases (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. More over 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.

By comparing the control group 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 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. 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 with insignificant difference as present in (Table 1).

Deaths in intervention group (who were followed by CPIS n=19) were insignificantly lower than those in control group (n=40) which suggest that the patient's outcome was affect by the age and the underlying morbidity and comorbidities which was assessd by APCHE II as present in (Table 2).

Similar study showed that 19 patients (63.3%) out of 30 MV patients were died versus 11 patients were discharged a life, the APACH II and CPIS were higher in non survivors than survivors [17].

Logistic regression was done in the current 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 3).

Other study revealed different results as they found in the multiple 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 [18].

Conclusion:

Mortality among MV patients was not affected by using the score and it's related to patient's condition at time of admission.

CPIS lowers the cost of medication generally and antibiotic cost specifically and 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.

Limitation of the study:

Empirical prescription of antibiotics which is related to physician's attitude and lacking the knowledge of the CPIS.

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تقييم كفاءة إستخدام مقياس الإلتهاب الرئوى الإكلينيكى على نتائج وتكلفة حالات التنفس الصناعى

الإلتهاب الرئوى المصاحب للتنفس الصناعى هو العدوى الأكثر شيوعا المرتبطة بالرعاية الصحية فى قسم العناية المركزة. وتحدث العدوى بكثرة وتكون مرتبطة بزيادة فى حدة المرض ونسبة الوفيات لدى الحالات الحرجة.

تهدف هذه الدراسة إلى تحسين النتائج الصحية لمرضى جهاز التنفس الصناعى من خلال المساعدة فى التشخيص المبكر للحالات، والعلاج المبكر بالمضادات الحيوية المناسبة بجرعات كافية تليها تغيير العلاج بناء على نتائج المعامل البكتيرية وإستجابة المريض. أيضا تهدف الدراسة إلى تقليل من تكلفة الإقامة على جهاز التنفس الصناعى وتكلفة إستخدام المضادات الحيوية.

تم إستخدام مقياس الإلتهاب الرئوى الإكلينيكى للمساعدة فى التشخيص المبكر لحالات الإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى ومتابعة إستجابة المريض للعلاج، كما قد تم إستخدامه بنجاح فى توجيه قرارات العلاج لمرضى الإلتهاب الرئوى، مما أدى إلى التقليل من الإستخدام المفرط للمضادات الحيوية وأيضا من خطر الإصابة بالبكتيريا المقاومة للمضادات الحيوية.

تم إستخدام مقياس الإلتهاب الرئوى الإكلينيكى فى اليوم الأول واليوم الثالث وفى اليوم الأخير من نزع الأنبوب من جهاز التنفس الصناعى، وكانت نتيجة المقياس أقل فى مجموعة التدخل فى اليوم الثالث بإختلاف كبير ذو دلالة إحصائية عن المجموعة الضابطة.

أيضا فى مجموعة التدخل متوسط تكلفة الأدوية أقل من المجموعة الضابطة وتكلفة المضادات الحيوية أقل بكثير مع وجود دلالة إحصائية فى المرضى الذين تم متابعتهم بإستخدام مقياس الإلتهاب الرئوى الإكلينيكى. كما أن حالات الوفاة أقل فى مجموعة التدخل.

كما وجد أن إستخدام مقياس الإلتهاب الرئوى الإكلينيكى لا يمثل خطر لحدوث الوفاة لدى حالات التنفس الصناعى وأن سبب الوفاة يرجع إلى التاريخ المرضى والأمراض المصاحبة.

نستنتج من هذه الدراسة أن مقياس الإلتهاب الرئوى الإكلينيكى يعتبر أداة لمراقبة حالة المرضى على جهاز التنفس الصناعى ورصد إستجابتهم للعلاج وللتعديل المبكر فى أنواع المضادات الحيوية المستخدمة مما ينعكس بدوره على مدة البقاء فى المستشفى وتكلفتها.