Original Research Article

Comparison Of Clinical Pulmonary Infection Score (CPIS) versus Johanson Criteria for The Diagnosis of Ventilator Associated Pneumonia (VAP)

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INTRODUCTION : A prospective observational cohort study was carried out in ICU patients requiring ventilatory support for 48 hours or more to compare the diagnostic tool of clinical pulmonary infection score (CPIS) versus Johanson criteria for the diagnosis of ventilator associated pneumonia (VAP).

MATERIAL AND METHODS : After obtaining approval from the ethics committee and informed written consent from the patient's relatives an observational study was carried out in 25 patients admitted to the ICU, in Government Medical College and Hospital Chandigarh, in a 2–month period. The inclusion criteria were adults(18-80 yrs)who required ventilator support for a minimum of 48 hrs. Patients with primary respiratory pathology and those not requiring ventilator or requiring ventilator for <48hrs were excluded from the study. The study group was regularly evaluated for development of VAP based on CPIS which was compared to Johanson clinical criteria. Data was expressed as median ±inter quartile range (QR), minimum-maximum. Fischer and Pearson, Chi-square tests and Mann-Whitney U test were used for statistical analysis. $p<0.05$ was considered as significant. The sensitivity, specificity and positive and negative predictive values (PPV, NPV) of CPIS were determined by comparing patients of VAP with non-VAP. CPIS evaluation included- body temperature, leucocyte count, tracheal secretions, oxygenation, chest x-ray findings and tracheal culture aspirate. The Johanson clinical criteria included- new infiltrates on chest x-ray and at least 2 of the following: leukocytosis, leucopenia, fever, hypothermia and/or purulent tracheal secretions.

RESULTS : Taking Johanson criteria as the reference standard, CPIS had a sensitivity of 60% and specificity of 90% on 3rd day which increased considerably by 5th day to 100% to 87.6%respectively.The PPV was 60% and 83.3% on the3rd and 5thday respectively. The corresponding NPV were 90% and 100% respectively.

CONCLUSION : CPIS can be used as an effective and comprehensive screening tool for the diagnosis of VAP which will help reduce over treatment significantly.

Introduction

Despite advancements in empirical antimicrobial therapy, early as well as late on set ventilator associated pneumonia (VAP) continues to represent a conspicuous clinical conundrum complicating the course of recovery in around 9-27% of mechanically ventilated patient.1,2 Ventilator associated pneumonia (VAP) has an effect both on mortality as well as length of ICU stay while contributing to increased expenses at the same time. 2,3Despite availability of surveillance, definitions laid by National Healthcare safety network (NHSN) 4, early

and accurate diagnosis of VAP still presents a significant challenge due to absence of an optimalreferencestandard.Severalscoresandcriteria havebeenproposedtodiagnoseandprognosticate VAP but all the parameters lack adequate specificity and sensitivity and demonstrate inter observer variability. CPIS was developed as a surrogate tool for diagnosis of VAP and the validation of same in terms of clinical importance and research tool is still limited. The present study was designed to assess the usefulness of CPIS score as a diagnostic tool for VAP taking Johanson clinicalcriteria as the reference standard.

Material and Methods

The present study was carried out in the Department of Anaesthesia and Intensive Care, of a tertiary care hospital. It was an observational, prospective cohort study carried over a period of 2 months in which 25 patients admitted to the ICU over the study period were included in the study.

After obtaining approval from the Institutional Ethics Committee and written informed consent from the relatives of the patients, adult patients between the ages of 18- 80 years requiring ventilator support for a minimum of 48 hours were included in the study. Patients being admitted to ICU with primary respiratory pathology, not requiring mechanical ventilation or requiring ventilator support for less than 48hours were excluded from the study. The enrolled patients were assessed after 48hours of initiation of mechanical ventilation for the development of VAP using Clinical Pulmonary Infection Score (CPIS) that was compared with the Johanson clinical criteria. Subsequently on the same day tracheal culture were sent for microbiological examination. The patients were again analyzed on the 5th day after admission with the availability of the culture reports and a comparison was drawn between the two modalities for development of VAP. A regular daily follow up of the enrolled patients was done to review the development of VAP and to assess the accuracy of the scoring system.

CPIS carries a maximum score of 12 with each parameter carrying an equal numerical value. A CPIS more than 6 was considered as threshold for the development of VAP. All the data was recorded in a prescribed data collection form. At the end of the study the data was organized and subjected to appropriate statistical analysis.

Statistical Methods

The statistical analysis was carried out by using statistical package for social sciences (SPSSIBM version 22). The normality of the data was evaluated by Kolmogorov-Smirnov test of normality, the data was found to be skewed, so data was expressed as median ± inter quartile range (IQR), minimum-maximum. Fischer and Pearson, Chi-square tests and Mann-Whitney U test analysis were used for statistical analysis of data. $p<0.05$ was considered as significant. The sensitivity, specificity and positive and negative predictive values (PPV, NPV) of CPIS were determined by comparing patients with VAP and non-VAP. A prior sample size could not be calculated as the present study was undertaken as a short term ICMR project to be completed over a period of 8 weeks and hence all the eligible patients were enrolled according to the inclusion criteria. From the number of patients enrolled in the study and data derived from it, ROC curve could not be plotted as there were no overlapping values in both the groups. The CPIS was calculated and compared against the reference standard Johanson criteria for early diagnosis of VAP.

Results

A total of 25 patients admitted to ICU during the study period were included in the study. The minimum age of the patient enrolled was 18 years and the maximum being 80 years with a mean age of 46.2years (Table I) Out of the total 25 patients, 16 were male (64%) and 9 patients were female(36%).

The first evaluation of the patients was performed on the 3rd day i.e.48 hours after admission in to the ICU and 5 patients were diagnosed to have developed VAP as per the Johanson criteria. Taking Johanson criteria as the reference standard, CPIS was used in the same set of patients for diagnosis of VAP. The sensitivity and specificity of CPIS in comparison to reference standard was found to be 60% and 90% respectively. (Table II) The results of the comparison implied that 60% of the patients

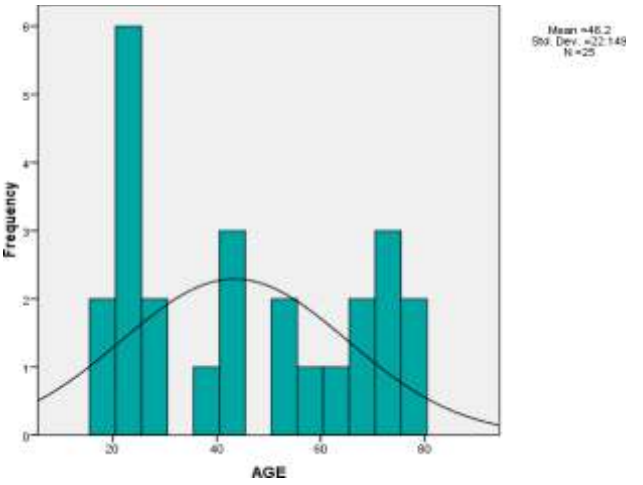
diagnosed by Johanson criteria were also diagnosed by CPIS and 90% of those diagnosed as not having VAP by Johanson criteria depicted correlation with CPIS as well.

The second evaluation performed on the 5th day after admission revealed 10 patients to have developed VAP using Johanson criteria. The use of CPIS on the 5th day revealed a sensitivity of 100% and a specificity of 86.7% when compared to the reference standard reflecting considerable increase in sensitivity of CPIS to diagnose VAP on 5th day of admission to ICU. (Table III)

RESULTS

Table I : Demographics

Measurement	Age
1. Mean	46.2
2. Standarddeviation	22.149
3. Median	45
4. Minimum	18
5. Maximum	80
6. Range	62



Out of the 25 patients in the study 16 (64%) were males and 9 (36%) were female

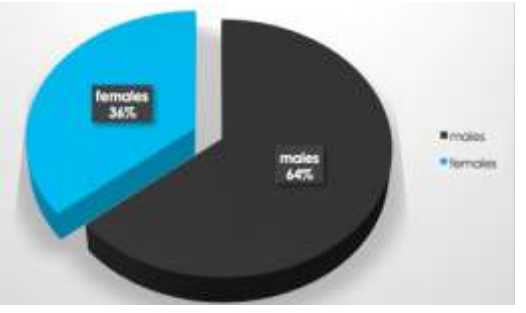


Table II : Findings on day3

CPIS		Johans on Criteria		Total
		Positive	Negative	
	Positive	3	2	5
	Negative	2	18	20
	Total	**5**	**20**	**25**

Sensitivity : 60% Positive predictive value : 60%
Specificity : 90% Negative predictive value : 90%

Table III : findings on day 5

CPIS		Johans on Criteria		Total
		Positive	Negative	
	Positive	10	2	12
	Negative	0	13	13
	Total	**10**	**15**	**25**

Sensitivity–100% Positive Predictive Value: 83.3%
Specificity–86.7% Negative Predictive Value: 100%

The positive predictive value was 60% and 83.3% on the 3rd and 5th day respectively. The corresponding negative predictive values were 90% and 100% respectively.

Discussion

With plethora of surveillance definitions available and absence of a gold standard, ventilator associated pneumonia (VAP) still poses significant challenge and remains a stumbling block in the timely diagnosis and treatment of VAP. The major concern is either under-diagnosis orover-diagnosis that leads to either delay in initiating treatment with resultant increased mortality or over prescription of antimicrobial agents resulting in development of resistance to frequently administered broad spectrum antibiotics.

In addition to being valid, reproducible, and reliable, an ideal marker of VAP should be noninvasive,facilitatingearlydiagnosisandrapidtreatmentandshouldbeabletoidentifythenon-responders to the antimicrobial therapy.1 While Johanson

criteria takes into account only the clinical features, CPIS introduced by Pugin et al has incorporated the biochemical, clinical, physiological and radiographic evidence to deriveanumerical value that predicts the presence or absence of VAP. 5 Broncho alveolar lavage has always been considered to be the most definitive method of diagnosis of VAP, but whether invasion of airway for BAL for diagnostic purposes has any effect on reduction of mortality or not is still an issue of debate. In addition, availability of costly equipment like bronchoscope is also not universal in many government sector ICUs

Therefore, clinical criteria for early diagnosis of VAP is still advocated and employed in most ICU settings. The validation of the available predictive models should be done from time to time to ascertainanypit falls in the application of criteria as well as the evaluation of results in a particular setup. This will rule out inter observer variability and refine the criteria in the long run. Therefore, the present study was undertaken as an ICMRSTS (Short term Studentship) project for evaluation, comparison and validation of CPIS against clinical criteria(Johnsons Clinical Criteria) in a tertiary care hospital.

The objective of this study was to compare Clinical Pulmonary Infection Score (CPIS) and Johan son Criteria for the diagnosis of VAP and as certain the sensitivity and specificity of CPIS by taking Johan son criteria as a reference standard.

Broncho alveolar lavage has also been compared with the scoring systems and clinical criteria for the diagnosis of VAP in several studies, but similar clinical outcomes and antibiotic usage have been observed using BAL ortracheal suctioning with endotracheal aspiration in suspected VAP patients. A Cochrane meta-analysis in 1,367 patients also observed no difference in the mortality with either invasive or non invasive diagnostic modalities in qualitative versus quantitative cultures. Therefore, we chose the Johanson clinical criteria as the surrogate reference standard in view of poor agreement and association of diagnosis of VAP with BAL to as certain whether the scoring systems still provide good validity even if the invasive criteria are not accounted for or omitted for assessing the development of VAP. 6, 7 From the results of the present study, CPIS was found to have a sensitivity of 60% and a specificity of 90% on the 3rd day as compared to Johanson criteria. But the sensitivity and specificity increased to 100% and 86.7% respectively on day 5 in comparison to Johanson criteria. The interpretation of the comparison implied that 60% of the patients diagnosed to have VAP by Johanson criteria were also diagnosed accurately by CPIS and 90% of those diagnosed as not having VAP by Johanson criteria depicted correlation with CPIS as well.

The second evaluation performed on the 5th day after admission revealed 10 patients to have developed VAP using Johanson criteria. The use of CPIS on the 5th day revealed a sensitivity of 100% and a specificity of 86.7% when compared to the reference standard reflecting considerable increase in sensitivity of CPIS to diagnose VAP on 5th day. (Table III). The inference that could be drawn from this observation was that CPIS compared well to the Johnsons Clinical Criteria for diagnosis of VAP on 5th day of ICU stay. Also, high specificity values on both 3rd and 5th day indicates that it is a good parameter for prediction of development of VAP especially in patients not demonstrating any underlying signs that give a clinical suspicion of VAP.

Even though the specificity was observed to be high for CPIS on both days of evaluation, the positive predictive values on the 3rd day and 5th day was observed to be 60% and 83.3%respectively. This implies that usefulness of CPIS as a tool for the diagnosis of VAP is more on 5th day in comparison to3rd day where its use could lead to possible under-diagnosis and delay in treatment and hence contributing to the mortality. Thus, the use of CPIS as a method for early diagnosis of VAP is limited as compared to the reference standard.

In continuation with the above results, the negative predictive values of CPIS on both the 3rdand the 5th day was observed to be high, i.e. 90% and 100% respectively which reflects CPIS as a good predictor for the absence of VAP on both the 3rd and the 5th day. Therefore, CPIS can be proposed as an effective screening test for the absence of VAP to reduce over treatment, development of resistance

and curtailing the expenses incurred with the use of antimicrobial agents. Screening with CPIS will help the clinicians eliminate the possibility of development of VAP with certainty and allow further underlying differential diagnosis, if any.

Despite being popular for diagnosis of VAP, inter observer variability has been found to be substantial with the use of CPIS. A meta-analysis of studies has reported pooled estimates of sensitivity and specificity of 65% and 64% respectively8. However, this meta-analysis did not include the surveillance definitions of VAP.

In evaluation of utility of CPIS and modified CPIS with the Centers for Disease Control (CDC) and National Healthcare Safety Network criteria, CPIS was found to have good correlation with NHSN criteria but did not offer major advantage for the VAP surveillance over it.4

On the contrary the utility and efficacy of the CPIS score has been demonstrated by Singh et al where the authors found no difference in the mortality and duration of stay in patients after early discontinuation of the antimicrobial treatment with CPIS <6as a surrogate marker for the same.9

Another meta-analysis to predict the accuracy of CPIS for diagnosing VAP found the summary receiver operating area under the curve to be 0.748 that indicated that CPIS had modest ability as a diagnostic tool for VAP.8 In the present study also, the diagnostic ability of CPIS was found to below to predict early VAP as compared to the clinical criteria.

Since CPIS employs the use of tracheal aspirates and use of time dependent variables likePaO2/FiO2 ratios in comparison to the clinical criteria alone, therefore it has an inherent theoretical advantage of better predictive power for diagnosis of VAP.

CPIS score has been found to be a fairly accurate method of diagnosing early VAP as well as restricting the unnecessary antibiotic use in neurologically ill patients also.2

There has been conflicting evidence in retrospective as well as prospective studies where CPIS has been found to poorly discriminate for development of VAP in culture positive and negative patients who had similar CPIS score.1, 10, 11

Although CPIS has been used as a marker to prognosis of mortality and morbidity in ICU with VAP, it was not observed to depict any significant relationship with mortality, duration of mechanical ventilation, duration of stay in ICU and hospital in patients with VAP.

The present study has limitations too: Since it was a period study to be completed over a stipulated period, therefore the number of the patients enrolled were less and the study could not have significant power. Therefore, further studies with greater sample size need to be undertaken to derive the factual results for applicability of the same to the critically ill population. The high specificity of CPIS on both the 3rd and the 5th days signifies the higher negative predictive value, thus future research studies can be undertaken to classify CPIS as a useful screening tool for VAP.

We also attempted to ascertain the extent to which CPIS could be used for diagnosis of VAP and its usefulness as compared to the other modalities of diagnosis based on risks to the patient, cost effectiveness and accuracy in diagnosis.

ANNEXURE

Table A

JOHANSON CRITERIA

JOHANSON CRITERIA	Presence of a new or a progressive radiographic infiltrate
	PLUS at least 2 of the following: ➢ body temperature >38°C; ➢ white blood cell count increased or decreased; ➢ purulent secretions.

TABLE B

CPIS

CPIS POINTS	0	1	2
Tracheal secretions	Rare	Abundant	Abundant and purulent
Chest x ray infiltrate	No	Diffuse	Localized
Temperature (degrees Celsius)	≥36.5 and ≥ 38.4	≥ 38.5 and ≤38.9	≤36.5 or ≥ 39.0
Leukocytes	>4000 and <11000	<4000 and >11000	<4000 or >11000
PaO2/FiO2	>240 or ARDS		≤240 and no ARDS
Microbiology	Negative		Positive

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