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ORIGINAL ARTICLE

SERUM PROCALCITONIN AND ITS RELATION TO THE OUTCOME OF VENTILATOR-ASSOCIATED PNEUMONIA IN CHILDREN

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Background: ***Ventilator associated pneumonia (VAP) is a common complication in intensive care patients. Procalcitonin may provide prognostic information in VAP.***

Objectives: ***The purpose of this study was to assess serum procalcitonin in diagnosis and prognosis of VAP in children.***

Methods: ***This was a prospective study performed in Pediatric Intensive Care Units (medical and surgical), Zagazig University Hospitals. They were classified into 2 groups: group (I) included 32 children with ventilator associated pneumonia (VAP): (20 males and 12 females) with mean age of 35.4 ± 18.1 months. Group (II) included 18 children did not have ventilator associated pneumonia: 10 males and 8 females with mean age of 30.9 ± 16.3 months. All patients were subjected to complete blood count, arterial blood gases, C-reactive protein and serum procalcitonin measurement using ELISA kit.***

Results: ***Group (I) patients had a high significant values of C-reactive protein, serum procalcitonin on day 1 and day 7. Mortality showed a high significant relation to C-reactive protein, serum procalcitonin on day 1 and day 7. There was a high significant positive correlation between serum procalcitonin on day 1 and both: WBC count, duration of ICU admission and duration of mechanical ventilation. Also, serum procalcitonin on day 7 showed a high significant positive correlation with both WBC count, CRP and duration of mechanical ventilation. On the other hand, serum procalcitonin on day 1 showed non-significant correlation to CRP while, serum procalcitonin on day 7 showed non-significant correlation to the duration of ICU admission.***

Conclusion: ***Measurement of PCT at onset and on the seventh day of treatment can predict survival of VAP pediatric patients. Serum procalcitonin levels decreased during the clinical course of VAP but were significantly higher from day 1 to day 7 in patients with unfavorable outcomes.***

Keywords: ***VAP, procalcitonin, children.***

INTRODUCTION

Ventilator associated pneumonia (VAP) is pneumonia in mechanically ventilated patients that develops later than or at 48 hours after the patient has been placed on mechanical ventilation. VAP is the second most common hospital-acquired infection among pediatric and Neonatal Intensive Care Unit (ICU) (NICU) patients with bloodstream infection being the first possible mode of transmission. It accounts for 20% of all nosocomial infections in this population.[1,2]

Overall, VAP occurs in 3 to 10% of ventilated Pediatric ICU (PICU) patients. The incidence of VAP is higher in

adult ICU patients, ranging from 15 to 30%.[3,4]

A study performed by Almuneef et al.[5] identified prior antibiotic use, continuous enteral feedings and bronchoscopy as being independent predictors of pediatric VAP.

On the other hand, Fayon et al.[6] found that immunosuppressant drugs, immunodeficiency, and neuromuscular blockade were also found to be other risk factors in VAP.

Procalcitonin (PCT) is a pre-pro-peptide precursor of the thyroid hormone calcitonin. Circulating levels of the precursor hormone PCT, derived primarily from non-thyroidal tissues, can rise several thousand times above normal in various inflammatory conditions, but most notably in bacterial infection.[7]

Procalcitonin has been demonstrated to be most clinically useful, and superior to commonly used clinical variables and laboratory tests in the diagnosis of sepsis; moreover, it has been shown to correlate with the extent and severity of microbial invasion.[8]

The aim of this study was to assess serum procalcitonin level in children with ventilator-associated pneumonia and the relation to outcome of VAP in those patients.

PATIENTS AND METHODS

This was a prospective study performed in Pediatric Intensive Care Units (medical and surgical), Zagazig University Hospitals from January 2011 to June 2011. Written consent was taken from relatives of patients and it was approved from Ethical Committee of Zagazig University Hospitals. Selected patients were admitted to ICU due to:

1. Intracranial hemorrhage (17 in group I,4 in group II).
2. Respiratory failure (6 in group I,2 in group II).
3. Renal failure (4 in group I,2 in group II).
4. Cerebral edema (5 in group I,10 in group II).

Patients were subdivided into the following groups:

Group I included 32 children admitted to pediatric ICU who had ventilator associated pneumonia (VAP): 20 males and 12 females with mean age of 35.4 ± 18.1 months.

Their mean ICU admission duration was 14.9 ± 4.5 days and mean mechanical ventilation duration was 11.9 ± 3.8 days.

Group II included 18 children admitted to pediatric ICU, mechanically ventilated but did not have ventilator associated pneumonia (VAP): 10 males and 8 females with mean age of 30.9 ± 16.3 months. Their mean ICU admission duration was 10 ± 2.8 days and mean mechanical ventilation duration was 4.9 ± 2.1 days.

All patients were subjected to the following:

- Full history taking.
- Complete physical examination.
- Complete blood count.
- Estimation of C-reactive protein.
- Estimation of serum procalcitonin level on the first and seventh day of diagnosis.

Diagnosis of pneumonia was suspected when a patient developed a new and persistent radiographic infiltrate plus two of the following:

1. Body temperature more than 38°C or less than 36°C.
2. White blood blood cells more than 11,000 or less than 4,000/mm^3.
3. Macroscopically purulent tracheal aspirate.

   Purulent endotracheal aspirate was defined on inspection by the assistant team. The axillary temperature used was the highest in the previous 24 hours before the inclusion on the study.[9]

Measurement of Procalcitonin (PCT) by ELISA:

- Serum procalcitonin was determined using ELISA kit (Uscn Life Science Inc. Wuhan, Cat. No.: E9068Hu).
- PCT values are physiologically increased during the first two days of life. The reference range for the first two days of life changes within a few hours. So, the adult reference range applies three days after birth.
- ***Samples:*** Serum separate tubes were used, venous samples were allowed to clot for 2 hours at room temperature before centrifugation, then serum stored in aliquot at -20°C.
- ***Kit components:*** 96-well strip plate precoated with antibody specific to PCT, standard (freeze dried), standard diluent, detection reagent A, detection reagent B, assay diluent A, assay diluent B, TMP substrate, stop solution and wash buffer.
- ***Procedure:***
  - Standard was reconstituted with 1 ml of standard diluent to prepare the stock solution (10,000 pg/ml) then diluted to 2,000 pg/ml which serves as highest standard. Then, serial dilution was done to get 7 points of diluted standard (2,000, 1,000, 500, 250, 125, 62.5 and 31.2 pg/ml) in addition to the blank (standard diluent only = 0 pg/ml).

- Detection reagents A and B were diluted using assay diluents A and B. Wash solution was prepared using distilled water.
- 7 wells were prepared for standards and one well for blank.
- 100 µl of samples (without dilution), standard and blank were added to appropriate wells, plate was covered with sealer and incubated for 2 hours at 37°C.
- Liquid was removed from wells without wash.
- 100 µl of detection reagent A was added to each well, incubated for one hour at 37°C.
- Liquid was aspirated, then washing with 350 µl of wash solution using multichannel pipette and remaining liquid was removed by snapping the plate onto absorbent paper. Wash was repeated 3 times.
- 100 µl of detection reagent B was added, then incubated for 30 minutes at 37°C.
- Aspiration/wash process was repeated for 5 times.
- 90 µl of substrate solution was added to each well, incubated for 15-25 minutes at 37°C, protected from light, liquid turned blue by addition of substrate.
- 50 µl of stop solution was added, the color turned into yellow, mixing by gentle tapping on plate side was done.
- Any drop of water on bottom of plate was removed.
- Measurement was done using microplate reader at 450 nm.

- ***Calculation:*** Average duplicate readings for each standard and sample were calculated, and then zero standard optical density was subtracted. Standard curve was created by plotting the mean absorbance for each standard on X-axis against concentration on Y-axis and drawing the best fit curve through the points on the graph.
- ***Sensitivity:*** The analytical sensitivity (limit of detection) of this ELISA assay is 7 pg/ml. The level of procalcitonin in serum of healthy individuals is below this limit.[10]

CRP determination:

Quantitative determination of C-Reactive Protein (CRP) in serum was done on Roche/Hitachi Cobas C system by particle-enhanced immunoturbidimetric assay. In normal healthy individuals, CRP is a trace protein with a range up to 5 mg/L.

Culture:

- Sterile endotracheal aspirates were obtained with a suction catheter adapted to a mucus collector without saline instillation.
- Aspirates were cultured on nutrient agar, blood agar, and McConkey agar media.
- Colonies of organisms grown on those media were identified by:
  - Colony morphology, pigment production (on nutrient agar) and type of hemolysis if present (on blood agar).
  - Gram-stained smears.
  - Gram +ve cocci further identified by arrangement of cocci, catalase and coagulase tests.
  - Gram –ve bacilli further identified by fermentation of fluid sugar media, Triple Sugar Iron (TSI) media, citrate test, urease test and Motility Indole Ornithine (MIO) media.[11]

    Culture of endotracheal secretions was done to patients of group I and revealed the following organisms: 17 Pseudomonas aeruginosa, 5 Staphylococcus aureus, 3 Enterobacter, 3 Klebsiella, 3 Acinetobacter species and one Streptococcus pneumoniae.

Statistical analysis: All analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 15 packed program.

Data were presented as mean ± standard deviation unless noted as different. Difference between the groups was analyzed using independent sample t-test and F-test. The relationships among the variables were analyzed using Spearman correlation test. A difference was considered significant at $p < 0.05$.

RESULTS

Table 1 shows demographic data of the studied groups: There was no significant difference regarding age and gender distribution. There was a high significant difference between both groups regarding duration of ICU admission and days of mechanical ventilation. Mortality, resolution and extrapulmonary infection were significantly higher in group I, while there was no significant difference in the recurrence of pathology that leads to mechanical ventilation.

Table 1. Demographic data of the studied groups.

Characteristics	Group I (n = 32)	Group II (n = 18)	Statistical test	p
Age (months)				
Mean ± SD	35.4 ± 18.1	30.9 ± 16.3	t = 0.86	0.38
Range	6-72	6-68		
Gender				
Male	20 (62.5%)	10 (55.6%)	X^2 = 0.23	0.63
Female	12 (37.5%)	8 (44.4%)		
ICU duration (days)				
Mean ± SD	14.9 ± 4.5	10 ± 2.8	t = 4.18	< 0.001**
Range	7-21	5-15		
Mechanical ventilation duration (days)				
Mean ± SD	11.1 ± 3.8	4.9 ± 2.1	t = 6.46	< 0.001**
Range	5-21	2-10		
Outcome				
Death	20 (62.5%)	2 (11.1%)	X^2 = 12.35	< 0.001**
Recurrence	3 (9.4%)	0 (0%)	X^2= = 0.052	0.47
Extra pulmonary infection	4 (12.5%)	8 (44.4%)	X^2 = 6.32	0.01*
Resolution	5 (15.6%)	8 (44.4%)	X^2 = 4.87	0.02*

P > 0.05 = Non-significant, p < 0.05 = Significant, p < 0.001 = Highly significant.

Table 2 shows laboratory criteria of the studied groups: Group II had a high significant values of C-reactive protein, serum procalcitonin on day 1 and day 7.

Table 2. Laboratory criteria of the studied groups.

Characteristics	Group I (n = 32)	Group II (n = 18)	t-test	p
WBCs (x 103/mm3)				
Mean ± SD	17.3 ± 4.6	15.5 ± 4.1	1.33	0.18
Range	10-29	8-23		
CRP (mg/L)				
Mean ± SD	24.4 ± 10.2	14.8 ± 4.3	3.79	< 0.001**
Range	8-48	8-23		
Procalcitonin day 1 (pg/ml)				
Mean ± SD	32.4 ± 11.2	17.4 ± 5.7	5.26	< 0.001**
Range	18-54	10-29		
Procalcitonin day 7 (pg/ml)				
Mean ± SD	24.1 ± 9.8	10.8 ± 2.8	5.6	< 0.001**
Range	11-45	7-17		

P > 0.05 = Non-significant, p < 0.05 = Significant, p < 0.001 = Highly significant.

Table 3 shows the relation between outcome and laboratory parameters in studied groups: mortality shows a high significant relation to C-reactive protein, serum procalcitonin on day 1 and day 7.

Table 3. Relation between outcome and laboratory parameters in studied groups.

	Death (n = 22)	Recurrence (n = 3)	Extrapulmonary infection (n = 12)	Healing (n = 13)	F	p
WBCs (x 10^3/mm^3)						
Mean ± SD	18 ± 5.2	13 ± 3.8	15.5 ± 3.7	16.3 ± 3.5	1.72	0.17
Range	8-29	10-16	10-20	12-23		
CRP (mg/L)						
Mean ± SD	28.5 ± 8.8	18 ± 13.2	15 ± 3.6	14.3 ± 4	15.05	< 0.001**
Range	8-48	8-33	9-21	9-20		
Procalcitonin day 1 (pg/ml)						
Mean ± SD	37 ± 10.4	22.7 ± 2.5	19.2 ± 5.9	18 ± 5.1	20.8	< 0.001**
Range	20-54	20-25	10-29	11-28		
Procalcitonin day 7 (pg/ml)						
Mean ± SD	28.8 ± 8.3	14.3 ± 3.5	11.9 ± 2.3	11.5 ± 3.8	31.7	< 0.001**
Range	15-45	11-18	8-15	7-19		

P > 0.05 = Non-significant, p < 0.05 = Significant, p < 0.001 = Highly significant.

Table 4 shows the correlation between serum procalcitonin and laboratory parameters, ICU admission and mechanical ventilation (MV) days: There was a high significant positive correlation between serum procalcitonin on day 1 and both WBC count (r = 0.52, p < 0.001), ICU duration (days) (r = 0.25, p < 0.001) and duration of mechanical ventilation (r = 0.46, p < 0.001). Also, serum procalcitonin on day 7 shows a high significant positive correlation with both WBC count (r=0.53, p<0.001), CRP (r=0.81, p<0.001) and duration of mechanical ventilation (r=0.5, p<0.001). On the other hand, both serum procalcitonin on day 1 shows a non-significant correlation to CRP (r=0.76, p>0.05) .While, procalcitonin on day 7 shows a non-significant correlation to duration of ICU admission (r=0.29, p>0.05).

Table 4. Correlation between serum procalcitonin and laboratory parameters, ICU admission and Mechanical Ventilation (MV) days.

	r	p
Procalcitonin D1 (pg/ml)		
WBCs (x 103 / mm3)	0.52	< 0.001** (HS)
CRP (mg / L)	0.76	> 0.05 (NS)
ICU duration (days)	0.25	< 0.001** (HS)
Mechanical ventilation duration (days)	0.46	< 0.001** (HS)
Procalcitonin D7 (pg/ml)		
WBCs (x 103 / mm3)	0.53	< 0.001** (HS)
CRP (mg / L)	0.81	< 0.001** (HS)
ICU duration (days)	0.29	> 0.05 (NS)
Mechanical ventilation duration (days)	0.5	< 0.001** (HS)

P > 0.05 = Non-significant, p < 0.05 = Significant, p < 0.001 = Highly significant
D1= day one
D7= day seven

(Fig. 1) shows a highly significant positive correlation between serum procalcitonin D1 (pg/ml) and WBCs (x 103/mm3) count in the studied groups (r =0.52, p <0.001).

(Fig. 2) shows a highly significant positive correlation between serum procalcitonin D7 (pg/ml) and WBCs (x 103/mm3) count in the studied groups (r = 0.53, p< 0.001).

(Fig. 3) shows a highly significant positive correlation between serum procalcitonin D7 (pg/ml) and CRP (mg/L) in the studied groups (r = 0.81, p< 0.001).

(Fig. 4) shows a highly significant positive correlation between serum procalcitonin D1 (pg/ml) and serum procalcitonin D7 (pg/ml) in the studied groups (r = 0.89, p< 0.001).

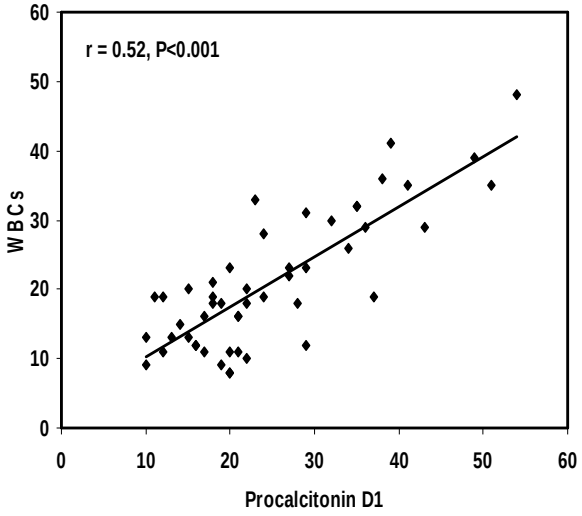

Fig 1. Correlation between serum procalcitonin D1 (pg/ml) and WBCs (x 10^3/mm^3) count in the studied groups.

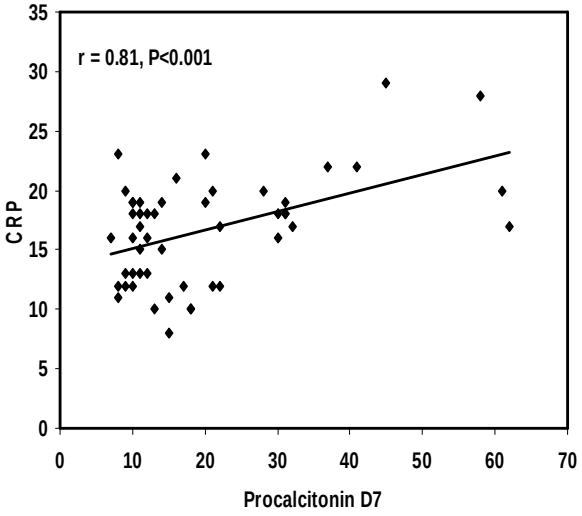

Fig 3. Correlation between serum procalcitonin D7 (pg/ml) and CRP (mg/L) in the studied groups.

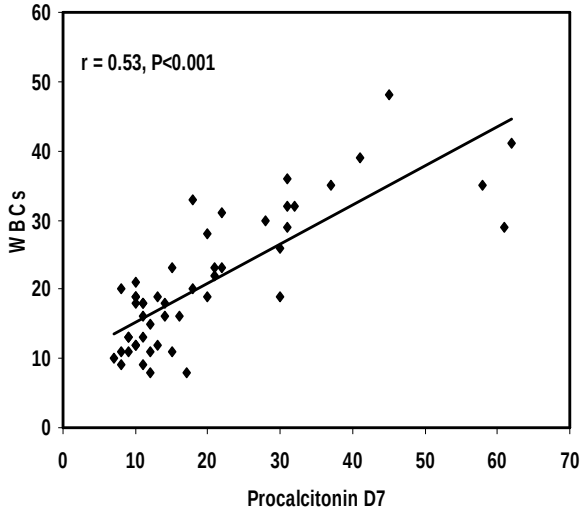

Fig 2. Correlation between serum procalcitonin D7 (pg/ml) and WBCs (x 103/mm3) count in the studied groups.

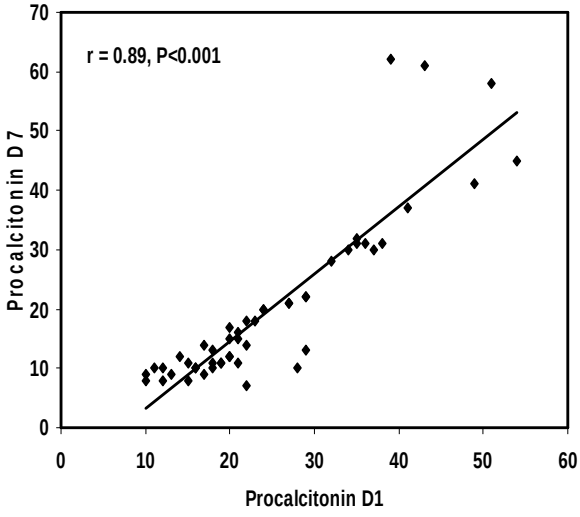

Fig 4. Correlation between serum procalcitonin D1 (pg/ml) and serum procalcitonin D7 (pg/ml)in the studied groups.

DISCUSSION

VAP is a non-homogenous multifocal and homogenous disease. The right lower lobe is the most commonly affected in the supine ventilated patients.[12]

In the present study, Peudomonas aeruginosa constituted 53.1% of causative organisms in VAP patients, while Staphylococcus aureus, actinobacter, enterobacter, klebsiella and pneumococci were found in 15.6%, 9.4%, 9.4%, 9.4% and 3.1% of cases respectively. On the other hand, Srinivasan et al.[13] found that the 3 most common organisms cultured in VAP patients were S. aureus, Haemophilus influenzae, and other Gram-negative organisms with the first 2 predominating in early VAP and the latter more common in late VAP. Of interest, they reported for the first time an incidence for polymicrobial VAP in pediatrics, which was 38% in their study.[13]

Combes et al.[14] reported a polymicrobial incidence of 48% in a cohort of adult ICU patients and found no difference in baseline demographics or outcomes between polymicrobial and monomicrobial VAP. Additional studies are needed to characterize any differences between monomicrobial versus polymicrobial pediatric VAP.

Our study showed that in VAP patients, the mean ICU admission duration was 14.9 ± 4.5 days and mean mechanical ventilation duration was 11.9 ± 3.8 days. While those who did not have ventilator-associated pneumonia (VAP), the mean ICU admission duration was 10 ± 2.8 days and mean mechanical ventilation duration was 4.9 ± 2.1 days. VAP patients were highly significant in mortality incidence, while those who did not have VAP had significantly more extra pulmonary infection and healing of the pathologic insult that leads to mechanical ventilation.

PCT is produced in the parenchymal cells in response to microbial toxins or inflammatory mediators such as Interleukin (IL)-1b and Tumor Necrosis Factor (TNF)-α. The level of PCT in healthy individuals is less than 0.1 ng/ml (the method used is enzyme-linked fluorescence assay, detection limit was 0.05 ng/ml) and remains low in individuals with viral and noninfectious diseases.[15,16]

Systemic PCT secretion is a component of the inflammatory response that appears to be relatively specific to systemic bacterial infections. Bacteraemic infections appear to cause the highest rises in PCT with lower or negligible rises in localized, viral and intracellular bacterial (e.g. Mycoplasma pneumoniae) infections. There is evidence that Gram-negative bacteraemias cause higher PCT rises than Gram positive bacteraemias.[17,18]

Our study showed a high significant serum levels of C-reactive protein, procalcitonin on day 1 and day 7 in VAP patients relative to group II. PCT seems to have a slight advantage over CRP because of its earlier increase upon infection and a better negative predictive value, as shown, for example, in children with fever or unknown origin and adult patients with systemic inflammatory response in critical illness, trauma and surgery.[19,20]

In the present study, mortality of studied cases (22 patients) showed a high significant relation to C-reactive protein (28.5 ± 8.8 mg/L), serum procalcitonin on day 1 (37 ± 10.4 pg/ml) and day 7 (28.8 ± 8.3 pg/ml).

On the other hand, Luyt et al.[21] assessed the value of PCT kinetics as a prognostic marker during VAP in 63 patients, with measures on days 1, 3 and 7. Unfavorable outcomes were death, recurrence of VAP, or occurrence of extrapulmonary infection requiring antibiotic treatment during the first 28 days of VAP. PCT levels in the sample generally decreased from D1 to D7 but increased in patients with unfavorable outcome.

For PCT analysis, the study by Luyt et al.[21] used the time-resolved amplified cryptate emission technology, an expensive apparatus not available worldwide.

Yentis et al.[22] demonstrated that a decrease in CRP by 25% or more from the previous day's level was a good indicator of resolution of sepsis, with a sensitivity of 97%,a specificity of 95% and a predictive value of 97%. The decrease in CRP preceded clinical resolution of sepsis and was more likely to occur in patients with less severe sepsis than in those with severe sepsis or septic shock.

Our study showed no significant relation between WBC count and outcome in studied patients. In the study of Lee et al.,[23] alveolar infiltrates were found to be associated with elevated levels of CRP, PCT and ESR, but not with the WBC count.

While in other previous studies, elevated CRP level and ESR, but not an elevated WBC count and PCT level, were found to be associated with alveolar infiltrates on chest X-rays.[24,25]

Seligman et al.[26] found that measurement of PCT and CRP at onset and the fourth day of treatment can predict the survival of patients with VAP. A decrease in either of these marker values predicts survival. The identification of those with good outcome as early as on day four could possibly help to ensure the adequacy of antimicrobial therapy. They found that PCT levels were significantly higher in non-survivors on D0 ($p = 0.003$) and D4 ($p < 0.001$). Furthermore, the decrease in PCT levels was significantly predictive of survival, with OR of 4.43.

Other studies on patients with VAP have reported higher PCT levels in non-survivors than in survivors.[27,28]

In a study with children with severe bacterial infection, Assicot et al.[29] reported that serum PCT values decreased rapidly during antibiotic therapy.

On the other hand, Hillas et al.[30] found that no difference was found in CRP levels between survivors and non-survivors adult patients with VAP. Non-survivors had significantly higher PCT levels on D1 and D7. VAP patients who developed septic shock had significantly higher CRP levels on D1 and D7 and higher PCT levels on D1 and D4. The only factor predicting the development of septic shock was Sequential Organ Failure Assessment (SOFA) on D1. They said that neither PCT and CRP threshold values nor their kinetics can predict VAP survival or septic shock development.[30]

In our study, serum procalcitonin was significantly higher in group I than patient group (32.4 ± 11.2 versus 17.4 ± 5.7 pg/ml on day 1 and 24.1 ± 9.8 versus 10.8 ± 2.8 pg/ml on day 7).

In Bloss et al.[31] study of severe pneumonia in mechanically ventilated patients, there was no difference in PCT levels between culture positive and culture negative pneumonia. Median PCT values of VAP survivors at baseline were 0.6 ng/ml in this study. It was measured by immunoluminometric assay, the optimal cutoff to predict mortality for initial PCT was 1.1 ng/ml.

Our results showed that the second sample of procalcitonin on day 7 decreased relative to first day sample. Mean serum procalcitonin was significantly high in non-survivors (37 ± 10.4 pg/ml on day 1 and 28.8 ± 8.3 pg/ml on day 7).

In another study on patients with severe pneumonia as defined by a high Pneumonia Severity Index (PSI), PCT correlated with outcome but could not differentiate between bacterial and non-bacterial etiology of pneumonia.[32]

Luyt et al.[33] found a similar low PCT of about 0.5 ng/ml in VAP survivors and doubted the usefulness of this parameter for diagnosis of VAP.

In a single center study conducted on 44 patients with VAP, Duflo et al.[22] found PCT to be significantly elevated in non-survivors: The best cut off for serum PCT in the non-survivors in the VAP group was 2.6 ng/ml with a sensitivity of 74% and a specificity of 75%.

Likewise, Luyt et al.[21] found high median PCT levels of about 3 ng/ml at day 1 in patients with unfavorable outcomes during the clinical course of microbiologically proven VAP (n=63). Interestingly, multivariate analyses further supported that serum PCT levels on days 1, 3, and 7 were strong predictors of unfavorable outcome.

Pelosi et al.[34] have found that in patients requiring mechanical ventilation as a result of severe brain injury, measurements of serum PCT level when the patients are first placed in ICU, along with clinical pulmonary score infection score can be useful in predicting which patients will subsequently have VAP.

Ramirez et al.[35] came up with the same findings and further added that CPIS and serum PCT below the cutoff point of 2.99 ng/ml are useful in excluding false-positive diagnosis of VAP since when used together they have a sensitivity of 100%.

In the absence of infection, however, PCT levels studied by the immunoluminometric method generally decline to below 1 ng/ml (or 1 µg/L) within 48 hours, pointing to the importance of repeated measurements of PCT with high-sensitivity assays.[36]

Our study showed that serum procalcitonin on day 1 was significantly high in non-survivors (37 ± 10.4 pg/ml) relative to those patients with recurrence, extrapulmonary infection or healing (22.7 ± 2.5, 19.2 ± 5.9 and 18 ± 5.1 pg/ml respectively). On day 7 of treatment, serum procalcitonin levels decreased but still higher in non-survivors in relation to other outcomes (28.8 ± 18.3 versus 14.3 ± 3.5, 11.9 ± 2.3 and 11.5 ± 3.8 pg/ml respectively).

Luyte et al.[21] showed that serum procalcitonin concentrations were higher in patients with unfavorable outcomes than in patients with favorable outcomes.

Regarding microbiologic diagnosis of VAP patients, the study of Almuneef et al.[5] showed that the mean duration of mechanical ventilation was 21 days for VAP patients and 10 days for non-VAP patients. The mean PICU stay was 34 days for VAP patients and 15 days for non-VAP patients. Among VAP patients, Pseudomonas aeruginosa was the most common organism, followed by Staphylococcus aureus. Other gram-negative organisms were also encountered. There was no significant difference between VAP and non-VAP patients regarding mortality rate.

Moreover, despite differences in the clinical presentations at VAP onset of the two groups, a serum procalcitonin threshold of more than 0.5 ng/ml studied by the immunoluminometric method on day 7 was the strongest independent marker of unfavorable outcome. Other clinical or biologic factors, such as WBC counts or C-reactive protein, were not able to discriminate between patients whose outcomes would be unfavorable and those with subsequent favorable outcomes. Furthermore, procalcitonin levels were higher as early as day 1 in patients whose outcomes would be unfavorable.[21]

Combes et al.[37] found that the radiologic score and the presence of acute respiratory distress syndrome on day 8 were associated with VAP recurrence, along with the persistence of fever and mechanical ventilation on day 8. However, the studies assessing the factors associated with either recurrence or death lacked a discriminatory marker of VAP prognosis.

CONCLUSION

- Serum procalcitonin is a useful marker of infection and it could be used as a complementary diagnostic marker of VAP.
- Measurement of PCT at onset and on the seventh day of treatment can predict survival of VAP pediatric patients. Serum procalcitonin levels decreased during the clinical course of VAP but were significantly higher with unfavorable outcomes.

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