# C-reactive protein in the early diagnosis of pneumonia complicating severe blunt chest trauma

## Intérêt de la protéine C-réactive dans le diagnostic précoce de la pneumonie compliquant un traumatisme thoracique grave fermé

Becem Trabelsi[1], Sahar Ghorbel[1], Rania Ben Rabeh[2], Mahdi Bouassida[3], Mechaal Ben Ali[1]

1. Department of Anesthesiology and Intensive Care, Taher Maamouri Teaching Hospital of Nabeul, Faculty of Medicine of Tunis, University of Tunis El Manar, Tunisia.
2. Pediatric Department C, Bechir Hamza Children's Hospital, Faculty of Medicine of Tunis, University of Tunis El Manar, Tunisia.
3. Department of Surgery, Taher Maamouri Teaching Hospital of Nabeul, Faculty of Medicine of Tunis, University of Tunis El Manar, Tunisia.

**Abstract**

**Background:** The early diagnosis of pneumonia following severe blunt chest trauma (SBCT) allows the early prescription of antibiotics and initiation of adequate supportive care.
**Aim:** To assess the usefulness of C-reactive protein (CRP) in the early diagnosis of pneumonia complicating SBCT.
**Methods:** We conducted a prospective study of patients admitted to trauma intensive care unit for SBCT between January 2020 and February 2023. Patients were divided into two groups according to whether or not they developed pneumonia. The CRP levels were monitored daily.
**Results:** One hundred sixty-seven patients were included. Pneumonia occurred in 40.1% of patients within a median of 5 days. We found statistically significant difference in mean CRP levels between groups from day 3 to day 9 following trauma. The increase in CRP level on the 4th day from a value greater than or equal to 192 mg/L was a marker of early diagnosis of pneumonia (sensitivity 80.6%; specificity 80.8%).
**Conclusion:** Daily CRP measurement from the 3rd day following SBCT may be useful for early diagnosis of pneumonia complicating SBCT.

**Key words:** Bacterial pneumonia, C-reactive protein, Complications, Multiple trauma, Thoracic injuries

**Résumé**

**Introduction:** Le diagnostic précoce d'une pneumonie compliquant un traumatisme thoracique grave fermé (TTGF) permet une prescription rapide d'antibiotiques et une optimisation de la réanimation.
**Objectif:** Évaluer l'intérêt de la protéine C-réactive (CRP) dans le diagnostic précoce de la pneumonie compliquant un TTGF.
**Méthodes:** Nous avons mené une étude prospective incluant les patients admis dans un service de réanimation chirurgicale pour TTGF entre janvier 2020 et février 2023. Les patients ont été répartis en deux groupes : groupe des patients ayant développé une pneumonie et groupe des patients sans pneumonie. Nous avons réalisé des dosages quotidiens de la CRP.
**Résultats:** Cent soixante-sept patients ont été inclus. Une pneumonie était survenue chez 40,1% des patients dans un délai médian de 5 jours. Le taux moyen de la CRP était significativement plus élevé du 3ème au 9ème jour suivant le traumatisme dans le groupe des patients ayant développé une pneumonie. Un taux de CRP supérieur ou égal à 192 mg/L au 4ème jour était un marqueur précoce de la survenue d'une pneumonie (sensibilité 80,6% ; spécificité 80,8%).
**Conclusion:** La mesure quotidienne de la CRP à partir du 3ème jour suivant un TTGF pourrait être utile pour le diagnostic précoce d'une pneumonie compliquant un TTGF.

**Mots clés:** Pneumopathie bactérienne, Protéine C-réactive, Complications, Polytraumatisme, Blessures du thorax

Correspondance
Becem Trabelsi
Department of Anesthesiology and Intensive Care, Taher Maamouri Teaching Hospital of Nabeul, Tunis, Tunisia.
Email: becem.trabelsi@fmt.utm.tn

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## INTRODUCTION

Severe blunt chest trauma (SBCT) is a common presentation to trauma intensive care units and is associated with high mortality (1). It causes a broad range of injuries and predisposes to secondary complications mainly pneumonia and acute respiratory distress syndrome (1). The early diagnosis of pneumonia not only allows the early prescription of antibiotics but also initiation of adequate supportive care (2). C-reactive protein (CRP) is a cheap and readily available laboratory test, known to be a sensitive marker of pneumonia (3). The aim of this study was to compare kinetics of CRP between patients without pneumonia and those with pneumonia following SBCT in order to assess the usefulness of CRP in the early diagnosis of pneumonia complicating SBCT.

## METHODS

We conducted a prospective study of all patients aged above 18 years old and admitted to trauma intensive care unit for SBCT during 3 years between January 2020 and February 2023. This study was approved by the local ethics committee. Patients with severe traumatic brain injury were excluded. All patients were submitted to standardized diagnostic and therapeutic protocols. Patients were divided into two groups according to whether or not they developed pneumonia. Pneumonia was defined according to 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society (4). The serum CRP levels were monitored daily for each group from admission until 10 days following the SBCT.

### Statistical analysis

The comparative analysis was carried out using student's t test or the Mann–Whitney U-test for continuous variables and $\chi^2$ tests for categorical data. To assess the usefulness of CRP level in the early diagnosis of pneumonia following SBCT, the area under the curve (AUC) was used. Sensitivity and specificity were calculated to determine the optimal CRP level cut-off when a statistical significance was observed in the AUC.

## RESULTS

Data of 167 patients were analyzed. The mean age was 47.4 ± 16.6 years. Seventy percent of patients were without medical history. There were no significant differences concerning age, sex and medical history between the groups. Twenty-five patients had isolated SBCT (15%), while 55 had spinal trauma (32.9%), 46 had abdominal trauma (27.5%), 43 had pelvic trauma (25.7%) and 63 patients had extremities trauma (37.7%). Rib fractures were observed in 94% of patients, followed by pneumothorax (67.6%), hemothorax (66.5%) and pulmonary contusion (37.7%). The median number of fractured ribs was 7 [1-21] resulting in flail chest in 29% of patients. Early invasive mechanical ventilation was required for 18 patients. Among them, 11 patients developed pneumonia.

Pneumonia occurred in 67 patients (40.1%). It was the most observed complication and occurred within a median of 5 days [3-10] following the trauma. Figure 1 showed that mean CRP levels from day 3 to day 9 following trauma were significantly higher in patients who developed pneumonia.

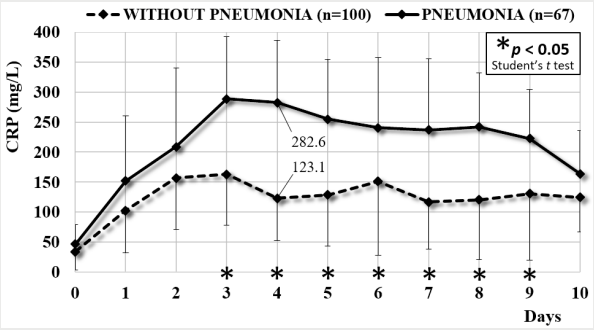


**Figure 1.** Kinetics of C-reactive protein (CRP) following severe blunt chest trauma

Analysis of the receiver operating characteristic (ROC) curve of CRP on day 4 showed an AUC equal to 0.900 (95% IC [0.822-0.978]) and a cut-off of 192 mg/L with a sensitivity of 80.6 % and a specificity of 80.8 % (Table 1).

The mortality rate in patients who developed pneumonia reached 24% and was 3% in patients without pneumonia (p < 10-3).

**Table 1.** Sensitivity and specificity of C-reactive protein level from day 3 to day 9 following severe blunt chest trauma (n=167)

| | | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 | Day 9 |
|---|---|---|---|---|---|---|---|---|
| Mean CRP levels | **Pneumonia (n=67)** | 288.5 ± 103.6 | 282.6 ± 103 | 255.1 ± 99.7 | 240.8 ± 116.1 | 237.1 ± 118.3 | 242 ± 89.6 | 222.9 ± 81.7 |
| (mg/L) ± SD | **Without pneumonia (n=100)** | 162.6 ± 84.8 | 123.1 ± 70.7 | 128.9 ± 85.9 | 151.3 ± 122.9 | 116.9 ± 78.7 | 120.5 ± 99.2 | 130.4 ± 110.8 |
| | ***p*** | $< 10^{-3}$ | $< 10^{-3}$ | $< 10^{-3}$ | 0.023 | 0.001 | 0.001 | 0.039 |
| AUC [95% IC] | | 0.825 [0.722-0.928] | 0.900 [0.822-0.978] | 0.834 [0.740-0.928] | 0.697 [0.518-0.877] | 0.787 [0.659-0.915] | 0.811 [0.621-1] | 0.783 [0.499-1] |
| Sensitivity (%) | | 71.9% | 80.6% | 75% | 64.5% | 71.9% | 78.8% | 79.2% |
| Specificity (%) | | 71.4% | 80.8% | 75% | 64.3% | 75% | 80% | 80% |
| Cut-off (mg/L) | | 233.5 | 192 | 181.5 | 208.5 | 150.5 | 168.5 | 153 |

CRP: C-reactive protein; AUC: area under the curve; IC: interval of confidence; SD: standard deviation.

## DISCUSSION

In this prospective study, the data showed that CRP levels were significantly higher in patients with pneumonia from day 3 to day 9 following severe SBCT.

Chest trauma is well known to be associated with respiratory complications (5) and consequently with higher mortality (2,6). The direct damage to the lung parenchyma and the activation of the inflammatory system following SBCT lead to the alteration of the alveolo-capillary barrier, the destruction of the lung parenchyma and the formation of necrosis. The limitation of coughing effort due to pain

in addition to increased alveolar secretions, impaired fluid clearance and colonization of the airways, lead to the formation of alveolar collapse and therefore occurrence of pneumonia. The diagnosis of pneumonia can be challenging in trauma patients since the classical combination of clinical, radiological and laboratory criteria are unreliable (7). CRP is a widely used biomarker known to rise in response to several conditions (8) and its capacities to distinguish an infectious state from an inflammatory state remain weak especially in trauma patients in whom CRP levels are most often elevated due to tissue damage. Nevertheless, markedly elevated CRP levels are most often associated with an infection (9).

Our findings demonstrate that the increase in the CRP serum level on the 4th day following the SBCT from a value greater than or equal to 192 mg/L was a marker of early diagnosis of pneumonia (sensitivity of 80.6% and specificity of 80.8%), preceding by one day the diagnosis of pneumonia. Our findings were similar to many studies that had shown the supposed role of CRP level in the diagnosis of ventilation associated pneumonia (10). Similarly to our findings, the mortality rate was higher in patients developing pneumonia following SCTB in several studies (5,11). That is why preventing and establishing an early diagnosis of pneumonia seem to be crucial.

Limitations

The main limitation of this study was it being a single-center study. However, the single-center character might exclude bias due to differences in management strategies of SBCT.

## CONCLUSION

Daily CRP measurement from the 3rd day following SBCT may be useful for early diagnosis of pneumonia. Other extended prospective studies on several centers and on a larger population may consolidate our results.

## REFERENCES


1. Kim M, Moore JE. Chest Trauma: Current recommendations for rib fractures, pneumothorax, and other injuries. Curr Anesthesiol Rep 2020;10(1):61-8.
2. Wutzler S, Bläsius FM, Störmann P, et al. Pneumonia in severely injured patients with thoracic trauma: results of a retrospective observational multi-centre study. Scand J Trauma Resusc Emerg Med 2019;27(1):31.
3. Almirall J, Bolíbar I, Toran P, et al. Contribution of c-reactive protein to the diagnosis and assessment of severity of community-acquired pneumonia. Chest 2004;125(4):1335-42.
4. Kalil AC, Metersky ML, Klompas M, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clin Infect Dis 2016;63(5):e61-111.
5. 5. Hofman M, Andruszkow H, Kobbe P, et al. Incidence of post-traumatic pneumonia in poly-traumatized patients: identifying the role of traumatic brain injury and chest trauma. Eur J Trauma Emerg Surg 2020;46(1):11-9.
6. Grubmüller M, Kerschbaum M, Diepold E, et al. Severe thoracic trauma – still an independent predictor for death in multiple injured patients? Scand J Trauma Resusc Emerg Med 2018;26(1):6.
7. Schellenberg M, Inaba K. Pneumonia in trauma patients. Curr Trauma Rep 2017;3(4):308-14.
8. Xu LB, Yue JK, Korley F, et al. High-Sensitivity C-reactive protein is a prognostic biomarker of six-month disability after traumatic brain injury: results from the TRACK-TBI study. J Neurotrauma 2021;38(7):918-27.
9. Vanderschueren S, Deeren D, Knockaert DC, et al. Extremely elevated C-reactive protein. Eur J of Intern Med 2006;17(6):430-3.
10. Póvoa P, Coelho L, Almeida E, et al. Early identification of intensive care unit-acquired infections with daily monitoring of C-reactive protein: a prospective observational study. Crit Care 2006;10(2):R63.
11. Chiumello D, Coppola S, Froio S, et al. Noninvasive ventilation in chest trauma: systematic review and meta-analysis. Intensive Care Med 2013;39(7):1171-80.