Impact of C-reactive protein and BMI on patient outcome in respiratory ICU in Abbassia Chest Hospital
Taher A. EL Naggar\textsuperscript{a}, Khaled M. Wagih\textsuperscript{a}, Hossam S. Mohamed\textsuperscript{b}

Introduction C-reactive protein (CRP) is the most widely used biomarker of infection in critically ill patients and some data are available on the morbidity and mortality in obese patients in the medical intensive care setting, but it is widely held that their outcomes are poor.

Aim of the work This study aimed to evaluate the impact of CRP and BMI on the outcome of patients admitted in the respiratory ICU (RICU) in Abbassia Chest Hospital.

Materials and methods This prospective study was carried out on 71 patients admitted to the RICU at Abbassia Chest Hospital from January 2011 to July 2011. A full assessment of history, a thorough clinical examination, length of stay (LOS), and need for mechanical ventilation were assessed, and BMI and CRP were measured.

Results There was a highly significant correlation between BMI categories and outcome in which the mortality rate was high among underweight patients; there was also a significant correlation with complications, wherein septicemia was more common in underweight patients. Complications of mechanical ventilation were more common in morbidly obese patients and nosocomial infection was more common in obese patients. The results showed an insignificant correlation between smoking, need for mechanical ventilation, duration of MV, LOS in ICU, and outcome in terms of the CRP level.

Conclusion The study concluded that CRP exerted an independent effect on the duration of mechanical ventilation (MV) and LOS in RICU. The mortality rate was high in underweight patients, but not in overweight, obese, or severely obese patients. *Egypt J Broncho* 2015 9:238–244 © 2015 Egyptian Journal of Bronchology.

Keywords: BMI, C-reactive protein, length of stay, respiratory ICU

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addressed this relation in either medical, surgical, or trauma ICUs, but never in a specialized respiratory ICU (RICU). We hypothesized that there would be a relation between BMI, CRP, and the patient outcome in the RICU.

**Aim of the work**
The aim of our study is to evaluate the impact of CRP and BMI on the outcomes of patients admitted in the RICU in Abbassia Chest Hospital.

**Material and methods**
This prospective study was carried out on 71 patients admitted to the RICU at Abbassia Chest Hospital from January 2011 to July 2011.

**Inclusion criteria**
Patients older than 20 years of age.
Patients’ first admission in the ICU who stay more than 24 h.

**Exclusion criteria**
Patients younger than 20 years of age.
Patients whose body weight cannot be measured (because of loss of consciousness or because they are bedridden).

All the patients were subjected to the following:

1. Full assessment of history either from the patient or his/her relative.
2. Thorough clinical examination.
3. Investigations: These included the following:
   - (a) Plain chest radiograph.
   - (b) Arterial blood gas analysis.
   - (c) Laboratory investigations; these included the following: blood sugar, liver profile, renal profile, complete blood count, and electrolytes.
   - (d) CRP assay using (Rapid Tex CRP Latex Test).
   - (e) Height and weight measurements in the first 2 h of admission.

The BMI was calculated as follows [7]:
Weight in kilograms/(height in meter)².
Patients were classified as follows:
Underweight: <18.5; normal weight: 18.5–24.9; overweight: 25–29.9; obese: 30–39.9; morbidly obese: ≥40.

(f) ECG 7 – Special investigations were performed according to the clinical condition, for example, echocardiography, ultrasonography, and computed tomography scan if needed.

(4) Length of stay (LOS), requirement of mechanical ventilation, or oxygen therapy.

**Expected values**
Normal adult levels of CRP are reported to be less than 12 mg/l. The CRP levels in patients with strongly positive CRP reactions had been detected to be as high as 330 mg/l [8].

**Statistical analysis**
The collected data were revised, coded, tabulated, and entered in a PC using the Statistical Package for Social Science. Data were presented and suitable analysis was carried out according to the type of data obtained for each parameter.

**Results**
This study included 71 patients admitted to Abbassia Chest Hospital in the ICU from January 2011 to July 2011.

This study included 44 men and 27 women, mean age 51.9 ± 15.2 years; the mean BMI was 26.65 ± 8.12 and the mean CRP was 19.39 ± 8.25.

Forty-two patients were mechanically ventilated; the mean duration of mechanical ventilation was 7.12 ± 7.23, the mean LOS in the ICU was 11.07 ± 8.5 days, and the mortality rate was 46.5%.

The relationship between the CRP result and mechanical ventilation among the study participants showed an insignificant correlation between the CRP result and mechanical ventilation, although increased CRP with mechanical ventilation (Table 1).

The relationships between the CRP result and outcome among the study participants are shown in Table 2 and Fig. 1 shows insignificant correlations between the CRP result and outcome, although mortality was high in patients with elevated CRP.

There was an insignificant correlation between the CRP result and length of ICU stay as shown in Table 3.

There was an insignificant correlation between the CRP result and the duration of mechanical ventilation as shown in Table 4 and Fig. 2.

There was an insignificant correlation between sex, smoking, different BMI groups, mechanical ventilation,

<p>| Table 1 Relationship between C-reactive protein result and mechanical ventilation among the study patients |
|--------------------------------------------------|-------------------------|---------------------|-----------------|--------------------|</p>
<table>
<thead>
<tr>
<th>CRP</th>
<th>Mechanical ventilation [N (%)]</th>
<th>P</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated</td>
<td>33 (78.6)</td>
<td>23 (79.3)</td>
<td>0.940</td>
</tr>
<tr>
<td>Normal</td>
<td>9 (21.4)</td>
<td>6 (20.7)</td>
<td></td>
</tr>
</tbody>
</table>

CRP, C-reactive protein.
complications, and outcome among patients with normal and elevated CRP as shown in Table 5.

There was an insignificant correlation between BMI groups in terms of age, serum CRP level, duration of mechanical ventilation, and LOS in ICU as shown in Table 6.

There was an insignificant correlation between BMI groups in relation to sex, smoking, serum CRP level, and need for mechanical ventilation; however, there was a significant correlation in terms of complications. Septicemia was more common in underweight patients. Complications of mechanical ventilation were more common in morbidly obese patients, nosocomial infection was more common in obese patients, whereas there was a highly significant correlation of outcome with the mortality rate, which was higher in the underweight group as shown in Table 7.

There was a highly significant correlation between the patients who died and those who survived in terms of complications; the most common cause of death was ARDS and septicemia as shown in Table 8.

Table 9 shows a highly significant correlation between the patients who died and those who survived in terms of CRP, C-reactive protein.
of diagnosis, and those diagnosed with malignancy had a poor outcome.

There was a highly significant correlation between patients with and without nosocomial infections in terms of LOS and duration of MV; patients with nosocomial infection had longer stay in ICU and the duration of MV was prolonged as shown in Table 10.

Discussion
During the last decade, the increase in the incidence of obesity in the general population has led to a higher number of obese patients being hospitalized in ICUs. However, the direct influence of obesity on ICU mortality remains controversial. Some data are available on morbidity and mortality in obese patients in the medical ICUs, but it is widely held that their outcomes are poor [6].

In the present study, there were 56 patients with elevated CRP; of those, 27 (48.2%) patients were smokers and 20 (35.7%) patients were nonsmokers, whereas nine (16.1%) patients were ex-smokers. We found that 33 (59%) patients needed mechanical ventilation, whereas 23 (41%) patients did not. Also, estimated 27 (48.2%) patients survived, whereas 29 (51.8%) patients died.

Table 6 Comparison between patients with different BMIs in terms of age, C-reactive protein, duration of mechanical ventilation, and length of ICU stay

<table>
<thead>
<tr>
<th>BMI group (mean ± SD)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Normal (years)</td>
<td>49.56 ± 12.66</td>
<td>43.54 ± 19.39</td>
<td>52.94 ± 17.02</td>
<td>58.65 ± 12.46</td>
<td>55.33 ± 3.27</td>
</tr>
<tr>
<td>CRP level (mg/l)</td>
<td>19.87 ± 8.69</td>
<td>17.45 ± 7.80</td>
<td>19.50 ± 10.59</td>
<td>19.85 ± 7.09</td>
<td>21.00 ± 6.00</td>
</tr>
<tr>
<td>Duration of MV (days)</td>
<td>6.40 ± 8.24</td>
<td>7.55 ± 6.70</td>
<td>7.57 ± 8.87</td>
<td>7.11 ± 7.75</td>
<td>7.00 ± 5.57</td>
</tr>
<tr>
<td>Length of hospital stay</td>
<td>11.89 ± 11.28</td>
<td>10.15 ± 8.15</td>
<td>10.06 ± 7.47</td>
<td>11.82 ± 6.00</td>
<td>11.33 ± 10.17</td>
</tr>
</tbody>
</table>

CRP, C-reactive protein.

Table 7 Description and relations between sex, smoking, C-reactive protein, mechanical ventilation, complications, and outcome among patients with different BMIs

<table>
<thead>
<tr>
<th>BMI group [N (%)]</th>
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</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15 (83.3)</td>
<td>7 (53.8)</td>
<td>9 (62.9)</td>
<td>10 (68.8)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Female</td>
<td>3 (16.7)</td>
<td>6 (46.2)</td>
<td>8 (57.1)</td>
<td>7 (41.2)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsmoker</td>
<td>5 (27.8)</td>
<td>5 (38.5)</td>
<td>8 (57.1)</td>
<td>7 (41.2)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>4 (22.2)</td>
<td>1 (7.7)</td>
<td>0 (0.0)</td>
<td>4 (23.5)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Smoker</td>
<td>9 (50.0)</td>
<td>7 (53.8)</td>
<td>9 (62.9)</td>
<td>6 (35.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>CRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>2 (11.1)</td>
<td>2 (15.4)</td>
<td>5 (29.4)</td>
<td>4 (23.5)</td>
<td>2 (33.3)</td>
</tr>
<tr>
<td>Elevated</td>
<td>16 (88.9)</td>
<td>11 (84.6)</td>
<td>12 (70.6)</td>
<td>13 (76.5)</td>
<td>4 (66.7)</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10 (55.6)</td>
<td>11 (84.6)</td>
<td>7 (41.2)</td>
<td>9 (52.9)</td>
<td>5 (83.3)</td>
</tr>
<tr>
<td>No</td>
<td>8 (44.4)</td>
<td>2 (15.4)</td>
<td>10 (58.8)</td>
<td>8 (47.1)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>9 (50.0)</td>
<td>1 (7.7)</td>
<td>11 (64.7)</td>
<td>12 (70.6)</td>
<td>2 (33.3)</td>
</tr>
<tr>
<td>Nosocomial Infections</td>
<td>1 (5.6)</td>
<td>3 (23.1)</td>
<td>2 (11.8)</td>
<td>3 (17.6)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>ARDS</td>
<td>2 (11.1)</td>
<td>1 (7.7)</td>
<td>2 (11.8)</td>
<td>1 (5.9)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Septicemia</td>
<td>3 (16.7)</td>
<td>7 (53.8)</td>
<td>0 (0.0)</td>
<td>1 (5.9)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>MV complications</td>
<td>3 (16.7)</td>
<td>1 (7.7)</td>
<td>2 (11.8)</td>
<td>0 (0.0)</td>
<td>2 (33.3)</td>
</tr>
<tr>
<td>Outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lived</td>
<td>8 (44.4)</td>
<td>1 (7.7)</td>
<td>12 (70.6)</td>
<td>14 (82.4)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Died</td>
<td>10 (55.6)</td>
<td>12 (92.3)</td>
<td>5 (29.4)</td>
<td>3 (17.6)</td>
<td>3 (50.0)</td>
</tr>
</tbody>
</table>

CRP, C-reactive protein.

Table 8 Comparison between the patients who died and those who survived in terms of complications

<table>
<thead>
<tr>
<th>Complications [N (%)]</th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lived</td>
<td>32 (91.4)</td>
<td>4 (40.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>2 (28.5)</td>
</tr>
<tr>
<td>Died</td>
<td>3 (8.6)</td>
<td>6 (60.0)</td>
<td>6 (100.0)</td>
<td>11 (100.0)</td>
<td>5 (71.5)</td>
</tr>
</tbody>
</table>
The mean ± SD LOS among patients with elevated CRP was 10.37 ± 5.02 days, compared with patients with normal CRP, which was 11.55 ± 9.17 days, and the duration of MV among patients with elevated CRP was 6.18 ± 5.84 days, compared with those with normal CRP, which was 10.56 ± 10.71.

This study found that there was an insignificant correlation between CRP in terms of smoking, need for MV and duration of MV, outcome, and LOS in ICU.

These results are not in agreement with those of Lobo et al. [9], who found that increased CRP concentrations were associated with organ failure, prolonged ICU stay, and high infection and mortality rates; the difference in the results between this study and our study was because of the different numbers of patients, different age groups, and the fact that the study was not carried out in the RICU.

The present study is in agreement with Wang et al. [10], who found an independent association between CRP level and ICU mortality.

This current study found that there was an insignificant correlation between CRP and need for mechanical ventilation, and this is not in agreement with Schuetz et al. [11]; these differences may have been because of the inclusion of patients with different diseases in our study, whereas the study of Schuetz et al. [11] was carried out only on H1N1 patients.

The present study showed that there was an insignificant correlation between the CRP results and the duration of MV, but Zimmerman et al. [12] showed that both BMI and CRP can be used to estimate the risk of prolonged MV in critically ill trauma patients and concluded that BMI less than 23.3 kg/m² or CRP greater than 10 mg/l at the time of discontinuation of MV were independent predictors of more than 7 days’ duration of MV.

The present study found an insignificant correlation in the LOS and CRP level and this is not in agreement with Bhattacharya et al. [13], who found that higher CRP levels result in longer duration of hospital stay and poor clinical and radiological recovery in patients with community-acquired pneumonia.

For BMI, in the present study, we found that 38 (53.5%) patients survived and 33 (46.5%) patients died; the patients who died were categorized in terms of BMI as follows: 10 (55.6%) patients were normal weight, 12 (92.3%) patients were underweight, five (29.4%) patients were overweight, three (17.6%) patients were obese, and three (50.0%) patients were morbidly obese.

The present study reported that there was high significance between different BMI categories and outcome, wherein the mortality rate was high among underweight patients, but this result was not in agreement with that of Lobo et al. [9], who found an increased risk of morbidity and mortality for morbidly obese patients, and critically ill morbidly obese patients had higher ICU mortality compared with nonobese patients. Because missing data were not detected because of the retrospective design of the study, it was difficult to draw a conclusion on the exact influence of BMI on mortality in this study; also, Honarmand and Safavi [14] showed that obese patients had a mortality rate that was 3.9 times greater than that of the normal-weight group. In addition, Lissner et al. [15] found that obesity defined as BMI greater than 27 was associated with a higher mortality rate among ICU patients. Also, Goulouk et al. [16] reported that, after they controlled for comorbidities, obesity was not associated with increased mortality in ‘seriously ill’ hospitalized patients, whereas Galanos et al. [17] showed that abnormal BMI had no significant influence on ICU mortality. In contrast to previous reports, the obese group showed a trend toward reduced mortality and reduced duration of ICU care and hospital stay compared with the underweight and normal groups.

| Table 9 Comparison between patients who died and those who survived in terms of diagnosis |
|-----------------------------------------------|---------------|-------------|---------------|----------------|-------------|
| Diagnosis [N (%)]                             | P             | Significance|
| Infections                                    | COPD/asthma   | ILD         | Malignancy    |                |
| Lived                                         | 9 (34.6)      | 20 (80.0)   | 4 (50.0)      | 0 (0.0)        | 0.001        |
| Died                                          | 17 (65.4)     | 5 (20.0)    | 4 (50.0)      | 6 (100.0)      | HS          |

COPD, chronic obstructive pulmonary disease.

<table>
<thead>
<tr>
<th>Table 10 Comparison between patients with and without nosocomial infection in terms of length of hospital stay and duration of mechanical ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nosocomial infection (mean ± SD)</td>
</tr>
<tr>
<td>P</td>
</tr>
<tr>
<td>Length of ICU stay (days)</td>
</tr>
<tr>
<td>Duration of MV (days)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>N (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPD/asthma</td>
<td>50</td>
<td>9 (34.6)</td>
</tr>
<tr>
<td>ILD</td>
<td>50</td>
<td>20 (80.0)</td>
</tr>
<tr>
<td>Malignancy</td>
<td>0</td>
<td>4 (50.0)</td>
</tr>
</tbody>
</table>

COPD, chronic obstructive pulmonary disease.
The data of the present study are in agreement with those of Lim et al. [18], who found increased mortality in the underweight patients in the medical and emergent surgical groups, but not in the elective surgical group, and also El-Solh et al. [6] in agreement with the present study as he found that low BMI was associated with increased mortality and worsened hospital discharge.

Obese patients have higher levels of leptin. Bornstein et al. [19] reported a positive association between leptin concentrations and survival of septic patients, suggesting that leptin could play a role in the adaptive response to critical illness. Also, Tremblay and colleagues [20,21] found increased mortality associated with underweight and obese patients, particularly in patients with higher levels of obesity, relative to the normal-weight category.

In addition, this study found that there was an insignificant correlation between different BMI categories in terms of LOS and duration of MV, and this was agreement with Peake et al. [22], who reported that there were no significant differences in the ventilation rate or weaning difficulties across the BMI categories. This was also in agreement with O’Brien et al. [23], who proved that obesity was not associated with increased length of ventilation and LOS. Moreover, the ICU readmission rate was similar across the BMI categories [14].

In the present study, there was an insignificant correlation between the outcome of different BMI categories in terms of age and this result was not in agreement with the study of Flegal et al. [24], who found excess mortality in younger patients that decreased considerably with age in all degrees of obesity, and also with Landi et al. [25], who reported that the mortality rate among elderly patients was greatest at the lowest BMI.

In the current study, complications of mechanical ventilation were more common in morbidly obese patients; this was in agreement with the main results of Allison et al. [26], who reported an increased incidence of specific complications in obese patients, including VAP.

Furthermore, in the current study, nosocomial infection was more common in obese patients, which was in agreement with Calle et al. [27], who found that the incidence and severity of nosocomial complications, particularly infections, and hospital mortality were higher in obese patients compared with lean patients.

In the present study, there was a highly significant correlation between patients who developed nosocomial infection and duration of MV and LOS. This is in agreement with Valencia and Torres [28], who found a significant increase in LOS and duration of MV. In terms of the outcome attributable to nosocomial infections, Fagon and colleagues [29,30] reported excess mortality, prolonged ICU stay, higher antibiotic consumption, and increased therapeutic activity, which led to considerable cost overruns.

Moreover, mortality was significantly higher among patients acquiring more than one nosocomial infection than in paired controls. The same results have been reported by Gendall et al. [31].

**Conclusion**

The study concluded that:

1. CRP is not a good marker of morbidity and mortality in RICU patients.
2. CRP exerted an independent effect on duration of MV and LOS in RICU.
3. Mortality rate was high in underweight patients, but not in overweight, obese, or severely obese patients.
4. BMI exerted no effect on duration of mechanical ventilation and LOS in the RICU.

**Acknowledgements**

**Conflicts of interest**

None declared.

**References**


