Impact of C-reactive protein and BMI on patient outcome in respiratory ICU in Abbassia Chest Hospital

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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

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Introduction

C-reactive protein (CRP) is a marker of inflammation that has been used to monitor the course of infection and inflammatory diseases. CRP has been considered not only as a biochemical marker of inflammation but also as an active modulator of the inflammatory response [1].

Numerous studies have reported increased CRP levels in patients with sepsis [2], but their relation to multiple organ dysfunctions and failure has not been well evaluated. Some studies have suggested that CRP may be an indicator of organ failure [3].

Serum CRP level began to be used as a diagnostic tool useful in determining the degree of activity and as a therapeutic guide for a number of conditions that commonly lead to marked changes in the plasma concentrations of acute-phase proteins [4].

The impact of obesity on outcome in critically ill patients has not been well studied. There are only a few comprehensive reviews that detail the management of obese critically ill patients. Hospitalized obese patients are at an increased risk of developing respiratory and other complications [5].

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 excessive body weight on ICU mortality remains controversial. Few data are available on morbidity and mortality in obese patients in the medical intensive care setting, but it is widely held that their outcomes are poor [6].

Problems in obese patients in the ICU may include difficulties with airway maintenance, disordered ventilation and gas exchange, impaired circulation, and altered drug pharmacokinetics. Procedures are more challenging, whether nonoperative (e.g. airway intubation, vascular access, neural blocks, urinary catheterization) or operative. Safe transport, repositioning, image acquisition, and mobilization can be major challenges requiring careful planning and execution. Of the many effects of obesity on various organ systems, we have chosen to focus on the following obesity-related disorders encountered commonly in the ICU that indicate the diverse effects through which obesity increases morbidity and complicates management [6].

All previously published studies of impact of CRP and BMI on patient outcome in critically ill patients have

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.

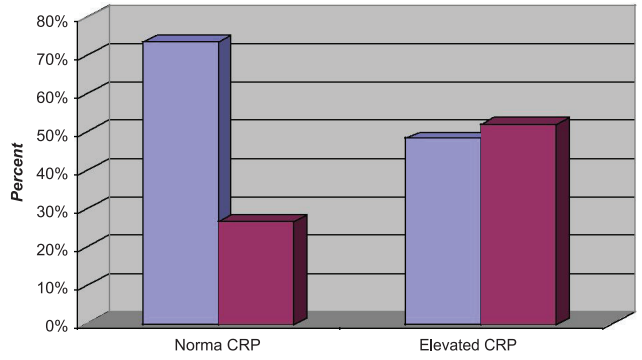
There was an insignificant correlation between sex, smoking, different BMI groups, mechanical ventilation,

Table 1 Relationship between C-reactive protein result and mechanical ventilation among the study patients

CRP	Mechanical ventilation [*N* (%)]		*P*	Significance
	Yes	No		
Elevated	33 (78.6)	23 (79.3)	0.940	NS
Normal	9 (21.4)	6 (20.7)		

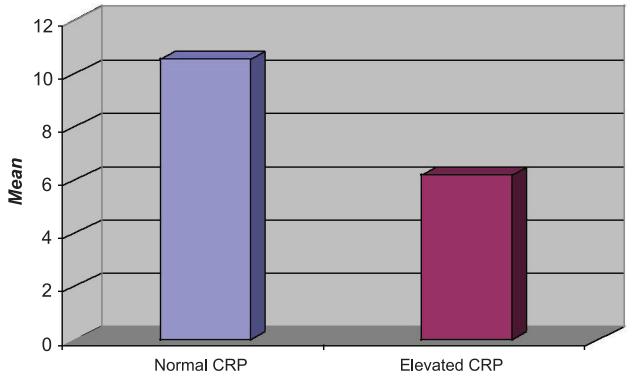
CRP, C-reactive protein.

Fig. 1



Relationship between C-reactive protein (CRP) result and outcome among the study patients.

Fig. 2



Relationship between C-reactive protein (CRP) result and duration of MV among the study patients.

Table 2 Relationship between C-reactive protein results and outcome among the patients studied

Patients outcome	CRP [*N* (%)]		*P*	Significance
	Normal	Elevated		
Lived	11 (73.3)	27 (48.2)	0.083	NS
Died	4 (26.7)	29 (51.8)		

CRP, C-reactive protein.

Table 3 Relationship between C-reactive protein result and length of stay in ICU among the studied patients who survived

CRP	Length of ICU stay (mean ± SD)	*P*	Significance
Elevated	10.37 ± 5.02	0.651	NS
Normal	11.55 ± 9.17		

CRP, C-reactive protein.

Table 4 Relationship between C-reactive protein result and duration of mechanical ventilation among the study patients

CRP	Duration of MV (mean ± SD)	*P*	Significance
Elevated	6.18 ± 5.84	0.284	NS
Normal	10.56 ± 10.71		

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

Table 5 Description and relations between sex, smoking, different BMI categories, MV, complications, and outcome among patients with normal and elevated C-reactive protein

Patient data	CRP [*N* (%)]		*P*	Significance
	Normal	Elevated		
Sex				
Male	8 (53.4)	36 (64.2)	0.634	NS
Female	7 (46.6)	20 (35.8)		
Smoking				
Ex-smoker	3 (20)	9 (16.1)	0.317	NS
Nonsmoker	8 (53.4)	20 (35.7)		
Smoker	4 (26.6)	27 (48.2)		
BMI				
Underweight	2 (13.3)	11 (19.6)	0.574	NS
Normal	2 (13.3)	16 (28.6)		
Overweight	5 (33.4)	12 (21.4)		
Obese	4 (26.6)	13 (23.2)		
Morbidly obese	2 (13.3)	4 (7.2)		
MV				
Yes	9 (60)	33 (58.9)	0.825	NS
No	6 (40)	23 (41.1)		
Complications				
Nosocomial infections	2 (13.3)	10 (17.9)	0.516	NS
ARDS	2 (13.3)	3 (5.3)		
Septicemia	1 (6.7)	11 (19.6)		
MV complications	2 (13.3)	4 (7.2)		
None	8 (53.4)	28 (50)		
Outcome				
Lived	11 (73.4)	27 (48.2)	0.083	NS
Died	4 (26.6)	29 (51.8)		

CRP, C-reactive protein.

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 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

	BMI group (mean ± SD)					*P*	Significance
	Normal	Underweight	Overweight	Obese	Morbidly obese		
Age (years)	49.56 ± 12.66	43.54 ± 19.39	52.94 ± 17.02	58.65 ± 12.46	55.33 ± 3.27	0.085	NS
CRP level (mg/l)	19.87 ± 8.69	17.45 ± 7.80	19.50 ± 10.59	19.85 ± 7.09	21.00 ± 6.00	0.936	NS
Duration of MV (days)	6.40 ± 8.24	7.55 ± 6.70	7.57 ± 8.87	7.11 ± 7.75	7.00 ± 5.57	0.997	NS
Length of hospital stay	11.89 ± 11.28	10.15 ± 8.15	10.06 ± 7.47	11.82 ± 6.00	11.33 ± 10.17	0.954	NS

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

	BMI group [*N* (%)]					*P*	Significance
	Normal	Underweight	Overweight	Obese	Morbidly obese		
Sex							
Male	15 (83.3)	7 (53.8)	9 (52.9)	10 (58.8)	3 (50.0)	0.300	NS
Female	3 (16.7)	6 (46.2)	8 (47.1)	7 (41.2)	3 (50.0)		
Smoking							
Nonsmoker	5 (27.8)	5 (38.5)	8 (47.1)	7 (41.2)	3 (50.0)	0.115	NS
Ex-smoker	4 (22.2)	1 (7.7)	0 (0.0)	4 (23.5)	3 (50.0)		
Smoker	9 (50.0)	7 (53.8)	9 (52.9)	6 (35.3)	0 (0.0)		
CRP							
Normal	2 (11.1)	2 (15.4)	5 (29.4)	4 (23.5)	2 (33.3)	0.620	NS
Elevated	16 (88.9)	11 (84.6)	12 (70.6)	13 (76.5)	4 (66.7)		
Mechanical ventilation							
Yes	10 (55.6)	11 (84.6)	7 (41.2)	9 (52.9)	5 (83.3)	0.108	NS
No	8 (44.4)	2 (15.4)	10 (58.8)	8 (47.1)	1 (16.7)		
Complications							
None	9 (50.0)	1 (7.7)	11 (64.7)	12 (70.6)	2 (33.3)	0.020	S
Nosocomial Infections	1 (5.6)	3 (23.1)	2 (11.8)	3 (17.6)	1 (16.7)		
ARDS	2 (11.1)	1 (7.7)	2 (11.8)	1 (5.9)	0 (0.0)		
Septicemia	3 (16.7)	7 (53.8)	0 (0.0)	1 (5.9)	1 (16.7)		
MV complications	3 (16.7)	1 (7.7)	2 (11.8)	0 (0.0)	2 (33.3)		
Outcome							
Lived	8 (44.4)	1 (7.7)	12 (70.6)	14 (82.4)	3 (50.0)	0.001	HS
Died	10 (55.6)	12 (92.3)	5 (29.4)	3 (17.6)	3 (50.0)		

CRP, C-reactive protein.

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

	Complications [*N* (%)]					*P*	Significance
	None	Hospital-acquired infections	ARDS	Septicemia	Complications of MV		
Outcome							
Lived	32 (91.4)	4 (40.0)	0 (0.0)	0 (0.0)	2 (28.5)	0.001	HS
Died	3 (8.6)	6 (60.0)	6 (100.0)	11 (100.0)	5 (71.5)		

Table 9 Comparison between patients who died and those who survived in terms of diagnosis

	Diagnosis [*N* (%)]				*P*	Significance
	Infections	COPD/asthma	ILD	Malignancy		
Outcome						
Lived	9 (34.6)	20 (80.0)	4 (50.0)	0 (0.0)	0.001	HS
Died	17 (65.4)	5 (20.0)	4 (50.0)	6 (100.0)		

COPD, chronic obstructive pulmonary disease.

Table 10 Comparison between patients with and without nosocomial infection in terms of length of hospital stay and duration of mechanical ventilation

	Nosocomial infection (mean ± SD)		*P*	Significance
	No	Yes		
Length of ICU stay (days)	9.19 ± 6.49	20.33 ± 10.93	0.0001	HS
Duration of MV (days)	4.34 ± 4.83	16.00 ± 6.55	0.0001	HS

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/m^2 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, Goulenok *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.

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.

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