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High Central Venous Pressure Associated with Mortality in Intensive Care Unit

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Abstract

BACKGROUND: Central venous pressure (CVP) has been used as a measurement tool to assess hemodynamics, medication, and nutritional status in critically ill patients for decades. We frequently use the Acute Physiology and Chronic Health Evaluation or Sequential Organ Failure Assessment score to predict the mortality of intensive care unit (ICU) patients. Unfortunately, it requires a lot of time and procedures to measure these parameters. Moreover, not every single hospital can apply these scores. Since CVP is widely used in ICU, we can use the value of CVP to predict mortality.

AIM: The aim of this study was to find the correlation between CVP and mortality rate.

METHODS: This cross-sectional study was conducted in ICU of Haji Adam Malik General Hospital, Medan, in 2017. Basic demographic data, CVP measurements and mortality were recorded among all ICU patients. Patients with CVP >12 mmHg were considered high. The association between CVP and mortality was analyzed.

RESULTS: One hundred patients were admitted during the study period with mortality rate of 38%. The most common cause of ICU admission was postoperative neurosurgical patients (28%). We found correlation between high CVP (>12 mmHg) and mortality among ICU patients (odds ratio: 3.372; 95% confidence interval: 1.349–8.428; p = 0.008)

CONCLUSION: CVP level >12 mmHg associated with higher mortality rate in ICU patients.

Introduction

The mortality rate of critically ill patients remains high. The Acute Physiology and Chronic Health Evaluation (APACHE) or Sequential Organ Failure Assessment (SOFA) scores are frequently used to assess the patient's mortality rate [1], [2]. The first APACHE score was introduced in 1981 with various parameters that influence the outcome of critically ill patients [3]. The later version, APACHE II, introduced in 1985, estimates the percentage of death rate based on 12 physiologic variables [4], [5] APACHE II score has been validated by many trials, and it is widely used to quantify the severity of critical illness in the intensive care unit (ICU).

The SOFA score is another scoring system consisting of six variables to check the severity of organ dysfunction or failure in ICU. The APACHE II and SOFA scores are calculated 24 h after admission to the ICU and every 48 h thereafter [1], [6]. The mean and the highest scores are most predictive of mortality. Unfortunately, it takes too much time to complete the existing data [2], [7]. Assessing these two scores are essential components in daily practice to predict the morbidity and mortality of ICU patients [1], [5], [6]. However, these measurements cannot be performed in all hospitals.

Central venous pressure (CVP) is a commonly measured parameter in ICU to check the adequacy of fluid in critical patients. Elevated CVP has been linked to excessive fluid in patient's body, whereas excessive fluid is associated with high mortality [8], [9], [10]. Several studies have reported that CVP can be used to predict organ failure, for example, kidney failure [11], [12]. It is expected that CVP can become a predictor of high mortality in future and can be regularly measured.

Methods

This cross-sectional study was conducted in ICU of Haji Adam Malik General Hospital, Medan, from January to December 2017. Adults patients (>18 years old) admitted to ICU were enrolled in this study. Basic demographic data, cause of ICU admission, CVP value and mortality were recorded in this study. CVP value >12 mmHg was considered high [9], [13], [14], [15]. Patients were treated with standard fluid and medication depending on the condition and diagnosis.

Data were then analyzed with SPSS version 18.0. Quantitative variables were expressed as mean and

standard deviation while categorical variables were described by absolute count (n) and relative (%) frequencies. The correlation between CVP and mortality was analyzed using Chi-square.

This study had been approved by the Ethics Committee of Universitas Sumatera Utara. All patients' families or guardians had been informed and agreed to participate in this study.

Results

One hundred patients were enrolled during this study period which consisted of 52 males and 48 females. The mean CVP was 9.5 ± 4.7 mmHg. The mortality rate of this study was 38% (Table 1).

Table 1: Characteristics of subjects

Characteristics	Value
Mean age (years) ± SD	48.5 ± 16.5
Mean weight (kg) ± SD	57.8 ± 9.8
Mean CVP (mmHg) ± SD	9.5 ± 4.7
Gender, *n* (%)	
Male	52 (52)
Female	48 (48)
Mortality, *n* (%)	
Yes	38 (38)
No	62 (62)

SD: Standard deviation, CVP: Central venous pressure.

Table 2 showed that the two most common causes of ICU admission were postoperative neurological care (28%), followed by neurological disorders (15%).

Table 2: Cause of intensive care unit admission (n = 100)

Diagnosis on admission	n (%)
Post-operative	41 (41)
Neurological	28
Gastrointestinal	8
Others	5
Neurological disorder	15 (15)
Infection	12 (12)
Pneumonia	4
Skin and soft tissue infection	2
Enteric infection	2
Urinary tract infection	1
Unspecified	3
Malignancy	10 (10)
Trauma	8 (8)
Cardiovascular disorder	4 (4)
Pulmonary disorder	4 (4)
Others	6 (6)

ICU: Intensive care unit.

We found a correlation between high CVP (>12 mmHg) and mortality in ICU patients (p = 0.008) with odds ratio of 3.372 (Table 3).

Table 3: Association between central venous pressure and mortality

CVP (mmHg)	Mortality (n)		p	Odds ratio (95% CI)
	Yes	No		
> 12	16	11	0.008	3.372 (1.349–8.428)
≤ 12	22	51		

CVP: Central venous pressure, CI: Confidence interval.

Discussion

This study identified that ICU patients with CVP >12mmHg were associated with higher mortality rate (odds ratio [OR]: 3.372; 95% confidence interval: 1.349–8.428; p = 0.008). The association of elevated CVP and poor outcomes has been reported in multiple studies [9], [16], [17]. Our result was in accordance with one of the latest meta-analysis by Chen *et al*. [18]. Elevated CVP level has been linked to higher mortality rate and morbidity. The study reported that higher CVP associated with increased risk of mortality (OR 1.65) and risk of acute kidney injury (OR 2.09). Furthermore, every increment of CVP by 1 mmHg will also increase the risk of acute kidney injury by 6%. One study in the US hospital reported that CVP was significantly higher among patients who did not survive than among those who got discharged (14.0 ± 5.9 vs. 11.7 ± 4.6 mmHg) [15].

Increased mortality may be caused by organ failures such as kidney or heart failure. The main concept of elevated CVP signifies an impeded venous return [19]. This congestion may be caused by edematous tissue which results in a compartment syndrome. Polycompartment syndrome which is caused by excessive fluid administration can disrupt oxygenation due to tissue edema. High CVP is a sign of excessive fluid administration which will impact cell oxygenation and perfusion [20].

Impeded venous return can also be seen in many cardiac problems including heart failure that is due to valvular disease, dysrhythmias, and decreased contractility (cardiogenic shock) [14]. Inadequate pump to push blood forward results in backup flow within the right ventricular and eventually increase the venous pressure. This condition is also similar in obstructive shock, for example, tension pneumothorax and cardiac tamponade [19], [21], [22]. Mechanically ventilated patients with high positive end-expiratory pressure (PEEP) tend to have higher CVP. This is mainly because higher PEEP results in higher pulmonary arterial resistance which eventually will also increase the venous pressure [14], [19]. Other factors that increase pulmonary arterial resistance should be considered, for example, decreased in fraction of inspired oxygen (FiO_2), ventilation-perfusion abnormalities, or increased in intraabdominal pressure (IAP) [14]. One study has reported that strong positive correlation between IAP and CVP (p = 0.0000; r = 0.7779) [23].

We must acknowledge several limitations in this study. First, this was a cross-sectional study and we only measured the CVP once when the patients were admitted to ICU. Multiple measurements in a range of time, for example, 72 h would have a greater power in this study. In addition, this study cannot prove the cause and effect between CVP and mortality. Additional causes of increased CVP that would likely increase the

odds of mortality include volume status, heart failure, renal failure, and the settings of mechanical ventilation with high PEEP. We were unable to exclude these factors due to the lack of high-resolution data. This is also a single-centered study in ICU of Haji Adam Malik Hospital, Medan. Further study is required to reconfirm this finding. We have high hope that CVP can represent organ failure that occurs in the same clinical value as the APACHE and SOFA scores.

Conclusion

CVP level >12 mmHg is associated with higher mortality in ICU patients, and it could be a simple predictor in addition to the APACHE and SOFA scores.

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