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The Impact of Intensive Care Unit-Acquired Weakness on Patients with Septic Shock

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Abstract

Objective: The study aimed to investigate the impact of Intensive Care Unit-Acquired Weakness (ICU-AW) on patients with septic shock.

Methods: Patients with pneumonia-induced septic shock admitted to our ICU were categorized into ICU-AW and non-ICU-AW groups based on the presence of ICU-AW during their ICU stay. Gender, age, length of stay in ICU, duration of mechanical ventilation, sedative dosage, medical charge, and 3-month mortality rate were compared between the two groups.

Results: The age, length of stay in ICU, duration of mechanical ventilation, midazolam dosage, total medical charge, and mortality rate in ICU-AW group showed higher then non-ICU-AW group (t/Z=-2.289, -16.366, -12.857, -7.178, -14.012, 4.687, P<0.05), and the differences were statistically significant.

Conclusion: ICU-AW occurrence in patients with septic shock was associated with increased length of stay in ICU, duration of mechanical ventilation, sedative dosage, medical charge, and mortality rate.

Keywords: Pneumonia; Sepsis; Shock; Intensive Care Unit-Acquired Weakness; Myasthenia; Complications; Prognosis.

Introduction

Every year, over 48.9 million people worldwide suffer from sepsis, with 11 million deaths reported [1]. Septic shock is a common critical condition in the Intensive Care Unit (ICU), characterized by rapid and unpredictable changes in the patient's condition and a high mortality rate [2]. It often necessitates treatment in the ICU. Under the influence of various factors, septic patients experience a significant decrease in limb muscle strength, manifesting as symmetrical functional impairment of the body, known as ICU-Acquired Weakness (ICU-AW) [3]. ICU-AW is a common complication in ICU patients, with a reported incidence of 40% according to Appleton et al.'s research [4]. Numerous studies suggest a clear correlation between sepsis and ICU-AW, with sepsis identified as a risk factor for ICU-AW [5,6]. The study observed the clinical impact of ICU-AW in patients with septic shock.

Materials and methods

Data source: Patients admitted to the comprehensive ICU of the People's Hospital of Qiandongnan Miao and Dong Autonomous Prefecture from January 1, 2022, to June 1, 2023, were selected for the study.

Inclusion criteria: Clear diagnosis of pneumonia, septic shock caused by pneumonia, age greater than 18 years.

Exclusion criteria: Cases affecting the diagnosis of ICU-AW, such as multiple myositis, severe central nervous system impairment, spinal and limb fractures, severe myasthenia gravis, etc. Patients who abandoned treatment or had incomplete data were excluded.

Diagnostic criteria: The diagnosis of septic shock adhered to the criteria outlined in Sepsis-3 [1]. The diagnostic criteria

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for ICU-AW were based on the Medical Research Council (MRC) muscle strength scoring system, encompassing 12 muscle groups in the upper and lower limbs. Patients with a total score <48 were diagnosed with ICU-AW [6].

Treatment methods: Upon admission, all patients were used comprehensive measures to maintain stable vital signs. Early shock management followed a bundled approach. Effective antibiotic therapy, tailored to disease characteristics and microbial culture results, was administered. Organ function support and maintenance of internal environmental stability were implemented for all patients.

Research methods: Patients admitted to the ICU underwent daily limb muscle strength measurements. The MRC muscle strength grading scale was used to score and record total points. Daily screening for ICU-AW was conducted. Upon ICU discharge, patients were categorized into ICU-AW and non-ICU-AW groups based on whether they developed ICU-AW during their ICU stay. Differences in gender, age, ICU length of stay, duration of mechanical ventilation, sedative dosage, medical expenses, and 3-month mortality rates were observed between the two groups.

Statistical methods: SPSS 26.0 software was utilized for data analysis. Normality of continuous data was assessed using the Kolmogorov-Smirnov test. Normally distributed continuous data were compared using independent sample *T*-tests, presented as mean ± standard deviation ($\overline{X}$ ±s). Non-normally distributed continuous data were compared using the Mann-Whitney *U* test, expressed as median (interquartile range) ($M(Q_L,Q_U)$). Categorical data were analyzed using the χ^2 test, presented as rates. Differences were considered statistically significant at P<0.05.

Results

A total of 500 cases were included in the study, consisting of 310 males and 190 females, with an average age of 63.86±17.95 years (range: 18-94 years). Among all patients, 224 had documented ICU-AW, and 276 had non-ICU-AW cases. There were 97 deaths and 403 survivors.

There was no significant difference in gender between the two groups (χ^2=1.745, *P*>0.05). The ICU-AW group exhibited higher age, length of stay in ICU, duration of mechanical ventilation, midazolam dosage, medical charge, and mortality rate compared to the non-ICU-AW group (*t*/*Z*=-2.289, -16.366, -12.857, -7.178, -14.012, 4.687, P<0.05), with statistically significant differences (Table 1).

Table 1: Comparison of two groups of data.

Parameter	ICU-AW group (n=224)	non-ICU-AW group (n=276)	$X^2/t/Z$	*P value*
Gender (Male/Female)	146/78	164/112	1.745	0.196
Age (Years)	65.89±18.46	62.213±17.48	-2.289	0.023
Length of stay in ICU (Days)	26 (16,34)	4 (1,8)	-16.366	0.000
Duration of mechanical ventilation (Hours)	130.00 (58.25,299.00)	7.50 (0,27.75)	-12.857	0.000
Dosage of Midazolam (mg)	110, (0,550)	0 (0,57.5)	-7.178	0.000
Total medical charge (RMB 10000)	8.65 (5.65,14.12)	3.02 (1.55,4.85)	-14.012	0.000
Mortality rate (%)	23.66	15.94	4.687	0.031

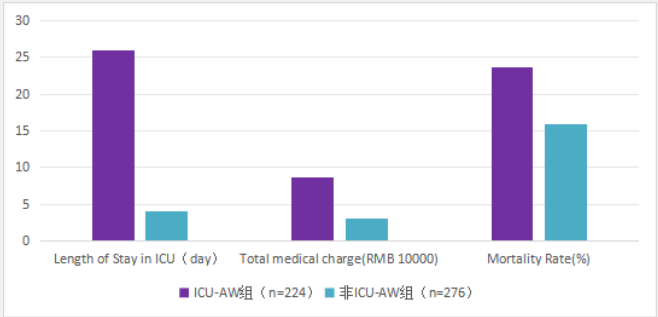

Figure 1: Comparison of the Length of stay in ICU, total medical charge, and mortality rate of two groups.

Discussion

Sepsis is a serious condition associated with organ failure in the clinic and requires intensive treatment in the ICU to reduce mortality. Research indicated that sepsis induces abnormal protein metabolism in the iliopsoas muscles through inflammatory mediators, resulting in protein loss and weakness in skeletal muscles [7]. Critical inflammatory mediators in sepsis, such as interleukin-1β, interleukin-6, and tumor necrosis factor-α, not only contribute to neurologic damage leading to septic encephalopathy and polyneuropathy but also trigger critical illness myopathy by influencing muscle protein metabolism [8]. Consequently, septic patients are at risk of developing acquired weakness.

The incidence of ICU-Acquired Weakness (ICU-AW) in septic patients ranges was between 50% and 100% [9,10]. Multiple factors collaboratively contribute to the occurrence of ICU-AW. Studies identified sepsis, mechanical ventilation, prolonged sedation, inadequate nutrition, and lack of exercise were significant contributors [11,12]. These factors exhibit interrelatedness and mutual influence. For instance, septic patients with respiratory failure may necessitate mechanical ventilation, which, in turn, requires sedation. Sedative use diminishes patient autonomy. Mechanical ventilation, prolonged sedation, and lack of exercise collectively foster the onset and progression of ICU-AW. This study revealed a correlation between the occurrence of ICU-AW and increased length of ICU stay, duration of mechanical ventilation, sedative dosage, medical expenses, and mortality rates. Other studies align with our findings [13]. Qiu Y et al. demonstrated prolonged hospitalization and mechanical ventilation in ICU-AW patients, coupled with increased overall hospital costs and elevated 28-day and 60-day mortality rates [14]. Dong XY's research found prolonged mechanical ventilation, extended ICU stays, and increased short-term mortality rates in ICU-AW cases [15]. Dres M's study indicated a significant impact of ICU-AW on weaning from mechanical ventilation and mortality rates [16]. Research also suggested a noticeable influence of ICU-AW on the short- and long-term prognosis of critically ill patients [17].

Our study results provided guidance for the recovery of patients with septic shock. Clinicians should prioritize monitoring muscle function, especially in patients requiring prolonged mechanical ventilation. Rational sedative management may aid in reducing the occurrence of ICU-AW. For patients requiring substantial sedation, cautious drug selection and a strategy to minimize sedative doses, where feasible, should be considered to mitigate the impact on muscle function.

Conclusion

In summary, the occurrence of ICU-AW in septic shock patients is associated with increased length of stay in ICU, duration of mechanical ventilation, sedative dosage, medical charge, and mortality rates. ICU-AW can lead to adverse clinical outcomes, necessitating early correction of septic conditions. Clinicians should intensify screening for ICU-AW and implement proactive and effective preventive measures to avoid its onset.

Declarations

Declaration of interests: The authors have no conflict of interest to declare.

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