Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 4
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Construction and Use of a Predictive Model for the Risk of ICU-acquired Weakness

Yaling Li[1]†, Baoyi Yang[2]†, Zhenzhen Rao[3]*

[1]Nursing Department, Taihe Hospital, Hubei University of Medicine, Shiyan 442000, Hubei, China
[2]Intensive Care Unit, Taihe Hospital, Hubei University of Medicine, Shiyan 442000, Hubei, China
[3]Neurological Intensive Care Unit, Xiangyang No. 1 People's Hospital (Affiliated Hospital of Hubei University of Medicine), Xiangyang 441000, Hubei, China.
† These authors contributed equally to this work and share the first authorship.

Author to whom correspondence should be addressed.

Abstract: *Objective*: To explore the risk factors of acquired weakness in ICU patients and construct a prediction model. *Methods*: Using convenience sampling method, 245 intensive care patients admitted to ICUs of three tertiary hospitals in Shiyan City from March 2022 to April 2023 were selected, of which 172 cases from March to December 2022 were used as the modeling group and 73 cases from January to April 2023 were used as the validation group. The predictive effect of the model was examined using the area under the curve (AUC) of the receiver operating characteristic curve (ROC) and Hosmer-Lemeshow goodness-of-fit, and the model column line graph was plotted. *Results*: The incidence of ICU-acquired weakness was 36.63% (63/172) and 38.37% (28/73) in the modeling and validation groups, respectively. Patient's history of alcohol consumption, mode of admission to the ICU, treatment with CRRT, mechanical ventilation, restraint braking, use of analgesics, use of norepinephrine, use of glucocorticoids, and length of stay in the ICU were the independent influencing factors of acquired weakness in ICU patients ($p < 0.05$). The AUCs of the modeling and validation groups were 0.979 and 0.887, respectively. *Conclusion*: The risk prediction model constructed in this study can predict the risk of acquired weakness in ICU, which can provide a reference for healthcare professionals to formulate interventions at an early stage.

Keywords: Intensive care unit; Acquired weakness; Influence factor analysis; Predictive modeling; Columnar plots

Online publication: Apr 30, 2026

1. Introduction

ICU Acquired Weakness (ICU-Acquired Weakness, ICU-AW) is a common and serious neuromuscular complication in critically ill patients, which is characterized by a range of symptoms such as limb paralysis and weakness, decreased reflexes and muscle atrophy [1]. Studies have shown that the incidence of ICU-AW ranges from 25% to 85% [1]. ICU-AW may lead to prolonged hospitalization, increased risk of nosocomial infections, decreased physical function after discharge, and increased mortality, which seriously affects the long-term quality of life of patients [2–5]. Currently, the pathogenesis of ICU-AW is unclear, and there is no effective pharmacologic approach to treat ICU-AW in the clinical setting; therefore, early prediction of the at-risk population and intervention is the most important approach to address ICU-AW, which can help improve patient safety and hospital resource management [1]. Predictive modeling" is based on the multimorbidity of a disease, and the establishment of a statistical model to predict the probability of a certain outcome event in a certain population in the future, which can help medical personnel to carry out "individualized treatment" and promote the "tertiary prevention" of the disease. Tertiary prevention" has been widely used in clinical practice [6–9]. Most of the studies on ICU-AW in China are limited to prognosis and risk factors, and there are fewer studies on integrating ICU-AW risk factors and constructing risk screening tools accordingly. In this study, by exploring the risk factors for the occurrence of ICU-AW and constructing its risk prediction model, this study aimed to identify high-risk groups early and provide reference for medical personnel to formulate prevention strategies.

2. Objects and methods

2.1. Research subjects

A prospective, observational study was used to facilitate the selection of intensive care patients admitted to the ICUs of three tertiary hospitals in Shiyan City from June 2022 to May 2023 as the study subjects.

2.1.1. Inclusion criteria

(1) Age ≥ 18 years old;
(2) Admission to ICU ≥ 24 hours;
(3) Patients were able to move their limbs according to the instructions;
(4) It was determined that there was no obstacle in the communication between the patients and the investigators.

2.1.2. Exclusion criteria

(1) Patients with ICU-AW before admission;
(2) Those with previous neuromuscular diseases or post-stroke sequelae;
(3) Patients with psychiatric disorders, speech disorders, etc. who were unable to cooperate with the examination;
(4) Incomplete case data.

2.1.3. Study design

The study was approved by the Ethics Committee of the hospital, and the investigators gave informed consent. The researcher screened 27 predictors after literature review and expert correspondence [4,10]. According to the requirements of the modeling sample size calculation formula, each independent variable needs to occur in 5–10 cases of ICU-AW patients, and the incidence rate of ICU-AW in ICU patients is 25–85% and 20% invalid samples are also considered, so that the calculated required sample size is at least 191 cases, and the final sample of this study was collected in 245 cases [1]. In a 7:3 ratio, 172 patients from March to December 2022 served as the modeling group and 73 patients from January to April 2023 served as the validation group.

2.2. Research methodology

2.2.1. Research tools

(1) Risk factor questionnaire

Through literature review and expert correspondence, based on the feasibility of survey implementation and the basis of previous research, the survey instrument of this study was determined [4,11]. It mainly includes: ① general information: gender, age, education level, history of smoking, history of drinking, history of hypertension, history of diabetes mellitus, body mass index (BMI); ② ICU-AW-related parameters of critically ill patients: mode of admission to the ICU, APACHE II score, whether or not shock, whether or not sepsis, whether or not multiple organ dysfunction syndrome (MODS), CRRT, mechanical ventilation, restraints, neuromuscular blockade, sedation, analgesia, norepinephrine, glucocorticoids, nutritional support, and length of stay in the ICU; iv. Laboratory indicators: albumin (lowest value), blood glucose (highest value), lactate (highest value), blood calcium (lowest value).

(2) Rapid diagnosis of ICU-AW

In this study, MRC score was used as recommended by the American Thoracic Society (ATS) in 2014 for the diagnosis of ICU-AW [12,13]. For example, patients with new-onset, flaccid, symmetrical weakness during ICU, and the following 3 items must be met: ① MRC score < 48 or 80% of the maximum possible score, and it lasts for at least 24 h. Includes 12 sets of measurement sites, including shoulder abduction, elbow flexion, wrist extension, hip flexion, knee extension, and ankle dorsiflexion bilaterally, with a score of 0 to 5 in each set, for a total score of 60, with higher scores indicating greater muscle strength. ② Evidence of weakness in all limbs tested. ③ Cranial nerve function was intact. The responsible nurse assessed the patient once a day, and when the MRC muscle strength grading score was ≥ 48, the patient was non-ICU-AW; if the MRC muscle strength grading score was < 48, the patient was assessed for the 2nd time on the morning of the 2nd day by another operator, and if the MRC score was ≥ 48, the patient was non-ICU-AW, and vice versa.

2.2.2. Data collection and quality control methods

At the beginning of the study, the researchers strictly followed the inclusion and exclusion criteria to determine whether the patients were enrolled and obtained informed consent, and after the consent of the supervising physician, the first assessment of MRC-score score ≥ 48 was allowed to enroll in the study, and after that, it was assessed by a fixed researcher at fixed time intervals of every 1 d until the study subjects reached the endpoint event or were dislodged. Endpoint event: occurrence of ICU-AW. shedding criteria: transfer out of ICU; withdrawal from the study; death. Patients' general data, ICU-AW-related parameters, and laboratory indicators were collected through an electronic medical record system, and all participating data collectors were uniformly trained to ensure study consistency. The data collected weekly were summarized by the investigator, and timely feedback and adjustments were made for problems in the data collection process. Data were entered using Excel 2010 two-person checking, and a dedicated person kept and verified 10% of the data to ensure the accuracy of data entry.

2.3. Statistical methods

SPSS26.0 and R4.2.1 software were used for statistical analysis. Measured information that meets the normal distribution was used to indicate, and those that do not meet the normal distribution were used Mann-Whitney rank sum test, and *t*-test was used for comparison between groups; counting information was used to indicate frequency and percentage, and 2-test or Fisher's exact probability method was used for comparison between groups. Logistic regression was used for the determination of independent influences and the construction of predictive models. Model fit was verified using Hosmer-Lemeshow, and the larger the p-value the better the fit ($p > 0.05$). The model column line graph was plotted against the receiver operating characteristic curve (ROC) by R4.2.1 to evaluate the prediction effect of the modeling and validation groups. The test level $\alpha = 0.05$.

3. Results

3.1. General information of the study population

A total of 245 patients were included in this study, 68.98% (169/245) were male and 31.02% (76/245) were female, age 20–86 years, median 60 (52,71) years. BMI (17.31–34.77) kg/cm^2, median 24.80 (23.22,27.34) kg/cm^2, ICU hospitalization Duration 1–18 days 4 (3,6) days. incidence of ICU-AW was 37.14% (91/245); incidence of myelosuppression in the modeling and validation groups was 36.63% (63/172) and 38.37% (28/73), respectively.

3.2. Univariate analysis of ICU-AW in patients in the modeling group

The data of the modeling group were divided into non-ICU-AW group and ICU-AW group based on whether acquired weakness occurred or not, and the differences between the two groups in terms of gender, age, education, smoking history, history of hypertension, history of diabetes mellitus, BMI, APACHE II score, use of neuromuscular blocking agents, mode of nutritional support, albumin, calcium, lactate, and blood glucose were not statistically significant ($p > 0.05$), and the differences between the two groups in terms of alcohol consumption History, mode of ICU admission, shock, sepsis, MODS, CRRT treatment, mechanical ventilation, restraint, use of sedation, use of analgesics, use of norepinephrine, use of glucocorticoids, and ICU length of stay were statistically significant ($p < 0.05$), as shown in **Table 1**.

Table 1. One-way analysis of ICU-AW in patients in the modeling group [n=172, cases (percentage, %)]

Name	Subgroup	Total	Non-ICU-AW group (n = 109)	ICU -AW group (n = 63)	Test statistic	*p value*
Gender	Male	122 (70.9)	73 (66.7)	49 (77.8)	2.261	0.133
	Female	50 (29.1)	36 (33.3)	14 (22.2)		
Age			59.0 (53.0，68.5)	67.0 (53.0，74.0)	-1.752	0.080
Education	Elementary and below	80 (46.5)	48 (44.0)	32 (50.8)	1.013	0.798
	Junior High School	59 (34.3)	39 (35.8)	20 (31.7)		
	High School/Middle School	22 (12.8)	14 (12.8)	8 (12.7)		
	College and above	11 (6.4)	8 (7.3)	3 (4.8)		
Smoking history	No	122 (70.9)	73 (66.7)	49 (77.8)	2.261	0.133
	yes	50 (29.1)	36 (33.3)	14 (22.2)		
Drinking history	No	127 (73.8)	75 (68.8)	52 (82.5)	3.897	0.048
	Yes	45 (26.2)	34 (31.2)	11 (17.5)		
Hypertension	No	79 (45.9)	54 (49.5)	25 (39.7)	1.563	0.211
	Yes	93 (54.1)	55 (50.5)	38 (60.3)		

Name	Subgroup	Total	Non-ICU-AW group (n = 109)	ICU -AW group (n = 63)	Test statistic	*p value*
Diabetes	No	143 (83.1)	91 (83.5)	52 (82.5)	0.026	0.873
	Yes	29 (16.9)	18 (16.5)	11 (17.5)		
BMI			24.7 (22.7，26.7)	24.8 (22.8，27.7)	-0.815	0.415
					3.385	0.336
		5 (2.9)	3 (2.8)	2 (3.2)		
		64 (37.2)	44 (40.4)	20 (31.7)		
		78 (45.3)	50 (45.9)	28 (44.4)		
		25 (14.5)	12 (11.0)	13 (20.6)		
ICU Admission	Postoperative transfer	34 (19.8)	29 (26.6)	5 (7.9)	9.322	0.009
	Ward transfer	50 (29.1)	31 (28.4)	19 (30.2)		
	Emergency transfer	88 (51.2)	49 (45.0)	39 (61.9)		
APACHEII score	≤ 15	76 (44.2)	47 (43.1)	29 (46.0)	0.137	0.711
	> 15	96 (55.8)	62 (56.9)	34 (54.0)		
Shock	No	150 (87.2)	101 (92.7)	49 (77.8)	7.928	0.005
	Yes	22 (12.8)	8 (7.3)	14 (22.2)		
Sepsis	No	139 (80.8)	102 (93.6)	37 (58.7)	31.269	< 0.001
	Yes	33 (19.2)	7 (6.4)	26 (41.3)		
MODS	No	140 (81.4)	104 (95.4)	36 (57.1)	38.613	< 0.001
	Yes	32 (18.6)	5 (4.6)	27 (42.9)		
CRRT treatment	No	158 (91.9)	104 (95.4)	54 (85.7)	5.023	0.025
	Yes	14 (8.1)	5 (4.6)	9 (14.3)		
Mechanical ventilation	No	70 (40.7)	55 (50.5)	15 (23.8)	11.748	0.001
	Yes	102 (59.3)	54 (49.5)	48 (76.2)		
Restraint braking	No	57 (33.1)	44 (40.4)	13 (20.6)	7.016	0.008
	Yes	115 (66.9)	65 (59.6)	50 (79.4)		
Neuromuscular blocking agents	No	170 (98.8)	109 (100.0)	61 (96.8)	3.501	0.061
	Yes	2 (1.2)	0 (0.0)	2 (3.2)		
Sedation	No	95 (55.2)	70 (64.2)	25 (39.7)	9.722	0.002
	Yes	77 (44.8)	39 (35.8)	38 (60.3)		
Analgesics	No	58 (33.7)	47 (43.1)	11 (17.5)	11.761	0.001
	Yes	114 (66.3)	62 (56.9)	52 (82.5)		
Norepinephrine	No	149 (86.6)	100 (91.7)	49 (77.8)	6.722	0.010
	Yes	23 (13.4)	9 (8.3)	14 (22.2)		
Glucocorticoid	No	98 (57.0)	80 (73.4)	18 (28.6)	32.722	< 0.001
	Yes	74 (43.0)	29 (26.6)	45 (71.4)		
Nutritional support modalities	Enteral Nutrition	70 (40.7)	48 (44.0)	22 (34.9)	2.914	0.233
	Parenteral Nutrition	81 (47.1)	46 (42.2)	35 (55.6)		
	Enteral + Parenteral	21 (12.2)	15 (13.8)	6 (9.5)		
Length of ICU stay			3.0 (2.0，4.0)	7.0 (5.0，9.0)	-10.029	< 0.001
Albumin (minimum)	0	117 (68.0)	76 (69.7)	41 (65.1)	0.396	0.529
	1	55 (32.0)	33 (30.3)	22 (34.9)		

Name	Subgroup	Total	Non-ICU-AW group (n = 109)	ICU -AW group (n = 63)	Test statistic	*p value*
Calcium	0	155 (90.1)	96 (88.1)	59 (93.7)	1.394	0.238
	1	17 (9.9)	13 (11.9)	4 (6.3)		
Lactate	0	78 (45.3)	49 (45.0)	29 (46.0)	5.133	0.162
	1	49 (28.5)	26 (23.9)	23 (36.5)		
	2	37 (21.5)	28 (25.7)	9 (14.3)		
	3	8 (4.7)	6 (5.5)	2 (3.2)		
Blood glucose	1	127 (73.8)	84 (77.1)	43 (68.3)	1.604	0.205
	2	45 (26.2)	25 (22.9)	20 (31.7)		

3.3. Multifactorial analysis and model construction of ICU-AW in patients in the modeling group

Variables with $p < 0.05$ in the univariate analysis were subjected to multifactorial analysis, and the values assigned to the independent variables are shown in **Table 2**. The results showed that the history of alcohol consumption, mode of admission to the ICU, treatment with CRRT, mechanical ventilation, restraining brakes, the use of analgesic, the use of norepinephrine, the use of glucocorticosteroids, and the length of stay in the ICU were the independent influences on the ICU-AW of the patients ($p < 0.05$), and the model was constructed as shown in **Table 3**. Draw a column line graph, see **Figure 1**, each risk factor in the column line graph has a corresponding score, the score of the four indicators in the model will be summarized to get the total score, from the location of the total score to draw a vertical line downward, and the value of its intersection with the probability of occurrence coordinates is the risk of ICU-AW of the patient.

Table 2. Assignment of independent variables

Independent variable	
Drinking history	0 = no, 1 = yes
Mode of ICU admission	0 = postoperative transfers, 1 = ward transfers, 2 = emergency transfers
Shock	0 = no, 1 = yes
Sepsis	0 = no, 1 = yes
MODS	0 = no, 1 = yes
CRRT treatment	0 = no, 1 = yes
Mechanical ventilation	0 = no, 1 = yes
Restraint braking	0 = no, 1 = yes
Sedation	0 = no, 1 = yes
Analgesics	0 = no, 1 = yes
Norepinephrine	0 = no, 1 = yes
Glucocorticoid	0 = no, 1 = yes
Length of ICU stay	Original value input

Table 3. ICU-AW multifactorial logistic regression analysis

	β	S.E.	Wald	*p*	OR	95% CI	
						Lower	Upper
Constant	-3.814	2.024	3.551	0.060	0.022	–	–
drinking history (yes)	1.827	0.935	3.822	0.051	6.216	0.995	38.817
Mode of ICU admission			6.764	0.034			
Mode of ICU admission (ward transfers)	3.373	1.317	6.555	0.010	29.159	2.205	385.584
Mode of ICU admission (emergency transfers)	1.802	1.117	2.603	0.107	6.063	0.679	54.130
CRRT treatment (yes)	-4.570	1.503	9.247	0.002	0.010	0.001	0.197
Mechanical ventilation (yes)	-2.411	0.949	6.455	0.011	0.090	0.014	0.576
Restraint Braking (yes)	3.102	1.105	7.882	0.005	22.253	2.551	194.087
Analgesics	-3.820	1.178	10.524	0.001	0.022	0.002	0.220
Norepinephrine (yes)	-3.047	1.110	7.530	0.006	0.048	0.005	0.419
Glucocorticoid (yes)	-1.318	0.729	3.267	0.071	0.268	0.064	1.118
Length of ICU stay	1.681	0.324	26.961	< 0.001	5.370	2.847	10.128

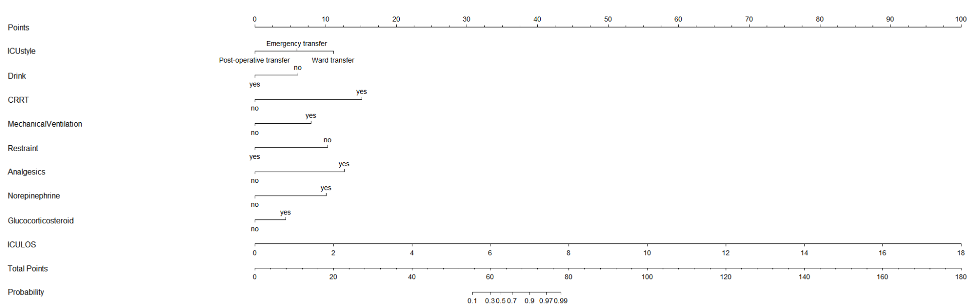

Figure 1. Column line diagram of the ICU-AW risk prediction model.

3.4. Validation of the ICU-AW risk prediction model

The risk probability of patients' myelosuppression was calculated according to the prediction model, with myelosuppression as the state variable and the prediction probability as the test variable, and the ROC curves of the modeling group and the validation group were plotted as in **Figure 2** and **Figure 3**.The values of the area under the curve (AUC) of the ROC curves of the modeling group and the validation group, and the 95% confidence intervals (CI) were shown in **Table 4**. (CI) are shown in **Table 4**. The calibration curves of modeling group and validation group were plotted by R4.0.2 as in **Figure 4, 5, 6** and **7**.

Table 4. Comparison of model prediction effectiveness between modeling and validation groups

Modeling groups	Sensitivity	Specificity	Yoden-index	Optimal threshold	AUC	*p value*	95% *CI*	
							Lower bound	Upper bound
Modeling group	0.921	0.927	0.848	0.316	0.979	0.000	0.962	0.995
Validation group	0.857	0.822	0.679	0.022	0.887	0.000	0.790	0.983

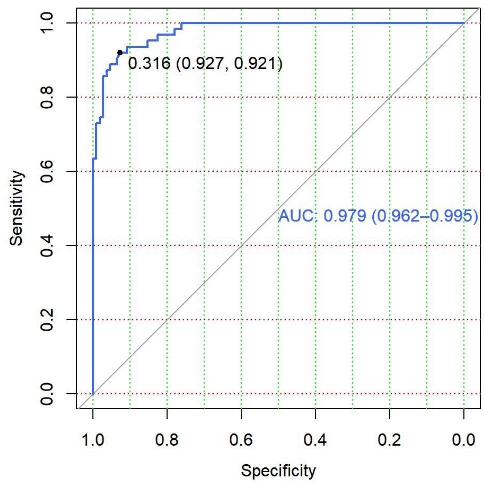

Figure 2. ROC curve for modeling group.

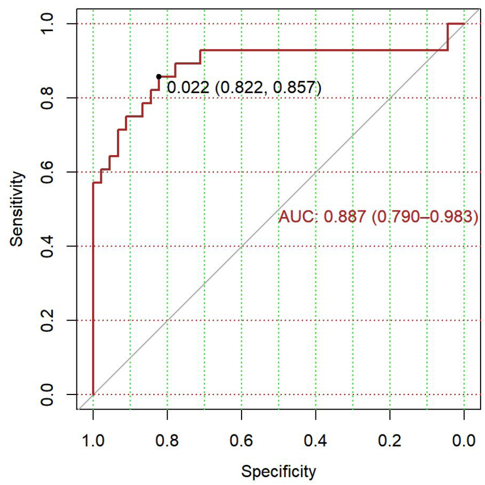

Figure 3. ROC curve for validation group.

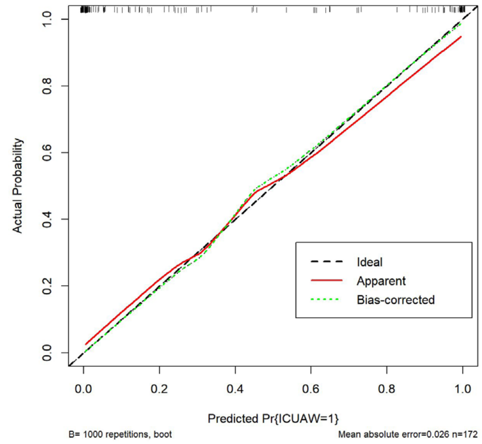

Figure 4. Modeling group calibration curve.

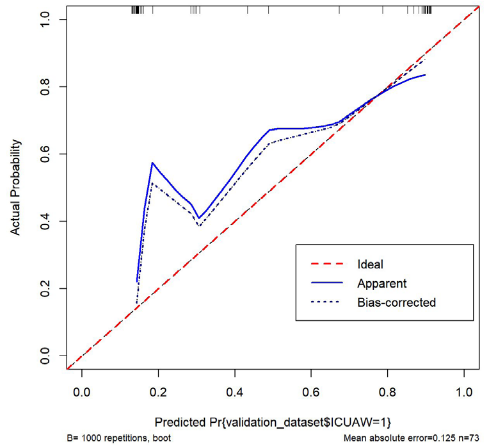

Figure 5. Verification group calibration curve.

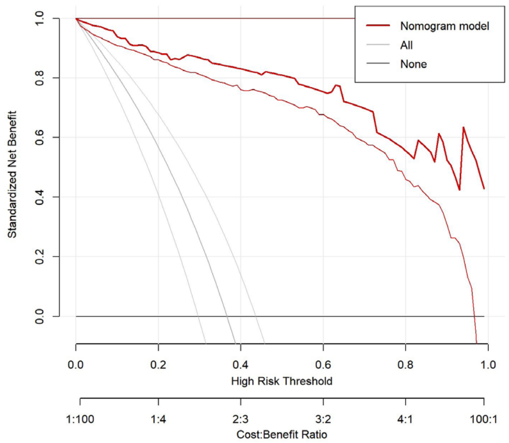

Figure 6. Modeling group decision curve.

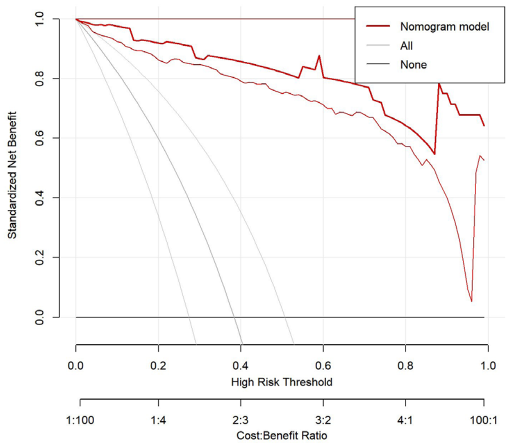

Figure 7. Validation group decision curve.

4. Discussion

4.1. Higher incidence of ICU-AW in patients

ICU-AW increases the hospitalization time of patients and affects their prognosis. Studies have shown that the incidence of ICU-AW in patients is 25–100%, indicating that the incidence of ICU-AW in patients is high [14]. The incidence of ICU-AW in patients in this study was 37.14% (91/245), which is in line with the range of the incidence of ICU-AW in previous studies, but the level is low. The reasons for this may be as follows:

(1) The study sites were all local tertiary hospitals, with relatively high medical standards and rapid ICU bed turnover;

(2) Under the influence of the concept of accelerated rehabilitation surgery, the rehabilitation training and education of patients are beneficial to the recovery of their muscle strength.

In this study, the mean age of occurrence of ICU-AW (49.25 ± 8.42) years has indicated that elderly patients are more likely to have ICU-AW, which is consistent with previous studies [15]. Therefore, the use of accurate and reliable assessment tools for patients' ICU-AW assessment is of great significance, and healthcare professionals should identify high-risk groups at an early stage and carry out accurate interventions and certain preaching, so as to help patients pass through the period of critical illness and improve their prognosis.

4.2. Analysis of independent influencing factors of ICU-AW in patients

4.2.1. Patients using norepinephrine are prone to ICU-AW

In this study, norepinephrine was found to be an independent risk factor for ICU-AW, which is consistent with previous studies [16–18]. The presence of β-adrenergic receptors on skeletal muscle is susceptible to the toxic effects of adrenergic drugs on skeletal muscle cells. This suggests that healthcare professionals should pay more attention to such patients [19].

4.2.2. Mechanical ventilation time, CRRT treatment as risk factors for ICU-AW

In this study, we found that the mode of admission to ICU, duration of mechanical ventilation, and CRRT treatment were risk factors for ICU-AW. It may be due to the fact that these patients are more severe, and previous studies have shown that the incidence of ICU-AW is as high as 33–82% in patients on mechanical ventilation for > 4d [20]. Prolonged mechanical ventilation makes patients' activities limited, the use of sedative and analgesic drugs increased, so that the synthesis and decomposition of myosin and actin are imbalanced, and muscle strength decreased; during mechanical ventilation, the diaphragm is difficult to play a role, which triggers atrophy and injury. Therefore, proper ventilation mode should be selected and the timing of extubation should be well grasped in the work. The pathogenic mechanism of renal replacement therapy may be that continuous dialysis leads to phosphate depletion and causes muscle weakness [21].

4.2.3. Patients with restraint braking are prone to ICU-AW

In this study, it was found that the risk of ICU-AW in patients with restraint braking was 22.253 times higher than that without braking (OR = 22.253, 95% CI: 2.551–194.087). ICU patients are prone to delirium, and restraint braking can safeguard the safety of patients against risky events such as falling out of bed and detachment of tubes, and it may also lead to patients with disuse atrophy of muscles, muscle At the same time, it may also lead to muscle wasting atrophy, muscle density decrease, muscle strength decrease, muscle metabolism disorder, and the older the patient and the longer the braking time, the more serious harm. In addition, long-term braking is prone to microcirculation disorders and malabsorption of the body's nutritional status, which leads to a decrease in the patient's muscle strength and further increases the risk of ICU-AW in patients. The study pointed out that activities in the early ICU can effectively reduce the incidence of muscle costal atrophy, however, early activities may also increase the occurrence of other risky events. Therefore, healthcare professionals should pay attention to the patient's consciousness, and when restraining brakes due to delirium and agitation, they should pay more attention to their restraining braking time and site, and assist in interventions such as changing positions and appropriate passive movement to prevent muscle injuries as much as possible. The American Association of Critical Care Nursing developed a program in 2009 that emphasized the importance of early activity and multidisciplinary collaboration as tolerated by ICU patients. Early activity in critically ill patients has a positive effect on reducing ICU-AW [22]. An early activity intervention team consisting of responsible nurses, bedside assistants, and rehabilitation physiotherapists conducts early functional exercises based on patients' awareness and condition, encouraging patients to actively participate in the program in a gradual and orderly manner, from passive activity to active activity, and from bedside activity to activity away from the bed, in order to achieve the purpose of delaying muscle atrophy and improving muscle strength [23–25]. When the patient's condition is stabilized, the responsible nurse will assist the patient to independently complete the basic daily activities such as dressing, washing, etc., and the patient can be assisted to sit up or get down to the ground if the condition permits, so as to prevent muscle weakness.

4.2.4. Patients with a history of previous alcohol consumption and use of analgesics are prone to ICU-AW

This study showed that patients with a history of previous alcohol consumption had developed ICU-AW, and the risk of ICU-AW in patients using analgesics was 6.216 times higher than that in patients not using analgesics (OR = 6.216, 95% CI: 0.995–38.817), which is consistent with the results of other studies. The frequent use of sedative analgesics by patients helps to relieve pain and improve oxygen consumption, but repeated use leads to prolonged braking and reduced activity, which is not conducive to the maintenance of normal muscle strength. The management model proposed by Vincent et al. for the patient who wishes to receive analgesia in comfort, minimal sedation and maximum humane care contributes to the patient's recovery [26]. Therefore, for patients receiving analgesia, the nurse can communicate with the physician about the patient's treatment and try to minimize analgesia to achieve therapeutic effects without increasing the risk of over-analgesia. For patients who must be given high doses of analgesics, attention should be paid to the frequency and practice of positional changes to try to avoid analgesia-induced prolonged braking.

4.2.5. Patients using glucocorticoids are prone to ICU-AW

In this study, it was found that the risk of ICU-AW was higher in patients after glucocorticoid use. Glucocorticosteroids are critical treatments for specific critically ill patients with strong anti-inflammatory and antifibrotic effects, shortening the duration of mechanical ventilation, reducing the incidence of organ failure and mortality in patients with refractory infectious shock. However, glucocorticoids cause changes in the expression of specific genes, causing endocrine disruption in the body, inhibiting protein synthesis, contributing to the redistribution of body fat, leading to muscle atrophy, and increasing the risk of ICU-AW [27].

4.2.6. Those with a longer stay in the ICU were prone to ICU-AW

Patients in the ICU-AW group had a longer stay in the ICU than those who did not develop ICU-AW, consistent with the findings of Hermans et al [28]. The occurrence of risky ICU stay for a long time may mean that the patients have a longer period to maintain stable condition, and the patients are more prone to ICU-AW as they have a heavier condition and a longer bedtime. In addition, the ICU in China is mostly a closed environment, and the patients need to face it alone during the treatment period, which inevitably produces fear, anxiety and other adverse emotions, and the psychological support of the patients is not satisfied, and the longer the stay in ICU, the more serious the patients' The longer the stay in ICU, the more serious the adverse emotions are, which in turn induces the occurrence of ICU-AW. When a healthy adult is bedridden for a long period of time, muscle strength will decrease by 1% per day [15]. Prolonged muscle inactivity causes changes in mitochondrial function, leading to an increase in reactive oxygen species, which results in muscle atrophy and dysfunction [29]. Therefore, healthcare professionals need to combine the patient's condition and willingness to provide the most favorable treatment and care plan for the patient, guide the patient to early rehabilitation exercise, increase the number of patients' bed activities, and reduce the risk of ICU-AW.

4.3. Scientific and practicality of ICU-AW risk prediction models

The Hosmer-Lemeshow fit test for the modeling group and validation group in this study was $\chi^2 = 1.687$ ($p = 0.989$) and $\chi^2 = 4.001$ ($p = 0.857$), respectively, and the P values of the two groups were > 0.05, and the calibration curves in **Figure 4** and **Figure 5** showed a better calibration, which indicated that the model had a better predictive ability. It is generally considered that AUC > 0.75 indicates that the model has a better prediction effect, and in this study, the AUC of the modeling group and the validation group were 0.979 and 0.887, respectively (p value < 0.01), and in the modeling group, the sensitivity was 0.921, the specificity was 0.927, and the Yoden index was 0.848, and in the validation group, the sensitivity was 0.857, the specificity was 0.822, and the Yoden index was 0.679, indicating that the model predicts better. When the prediction probability is ≥ 0.022, the patient's risk of ICU-AW is high, and healthcare workers should pay close attention to it [30]. History of alcohol consumption, mode of ICU admission, shock, sepsis, MODS, CRRT treatment, mechanical ventilation, restraint, use of sedation, use of analgesics, use of norepinephrine, use of glucocorticosteroids, and ICU length of stay were independent influences on patients' ICU-AW, suggesting that healthcare professionals should pay closer attention to such patients. The column-line diagram model constructed in this study was used to assess the influence of each factor on patients' ICU-AW, calculate the risk probability, and provide timely individualized intervention.

5. Conclusion

The incidence of ICU-AW in patients is high, and the mode of patient admission to ICU, history of alcohol consumption, CRRT treatment, mechanical ventilation, restraint braking, use of analgesics, use of norepinephrine, use of glucocorticoids, and length of stay in the ICU are the independent influencing factors of ICU-AW in patients. The risk prediction model constructed in this study has good specificity and accuracy, which can help to screen ICU-AW high-risk groups for early intervention. Shortcomings: the sample size of this study is small, and future studies should expand the sample size and further optimize and improve it in multicenter studies.

Funding

Philosophy and Social Science Program of Hubei Provincial Department of Education (Project No.: 21D074)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Khalil A, Alamri R, Aljabri G, et al., 2023, A Cross-Sectional Study of the Impact of ICU-Acquired Weakness: Prevalence, Associations, and Severity. Cureus, 15(12): e49852.

[2] Zhong F, Zhang H, Peng Y, et al., 2024, A Predictive Nomogram for Intensive Care-Acquired Weakness after Cardiopulmonary Bypass. Annals of Thoracic and Cardiovascular Surgery, 30(1): 23-00029.

[3] Chen J, Huang M, 2024, Intensive Care Unit-Acquired Weakness: Recent Insights. Journal of Intensive Medicine, 4(1): 73–80.

[4] Elkalawy H, Sekhar P, Abosena W, 2023, Early Detection and Assessment of Intensive Care Unit-Acquired Weakness: A Comprehensive Review. Acute and Critical Care, 38(4): 409–424.

[5] Liu J, Xu Z, Luo S, et al., 2024, Risk Factors for ICU-Acquired Weakness in Sepsis Patients: A Retrospective Study of 264 Patients. Heliyon, 10(11): e32253.

[6] Huang J, Yang J, Qi H, et al., 2024, Prediction Models for Amputation after Diabetic Foot: Systematic Review and Critical Appraisal. Diabetology & Metabolic Syndrome, 16(1): 126.

[7] Gonzalez R, Nejat P, Saha A, et al., 2024, Performance of Externally Validated Machine Learning Models Based on Histopathology Images for the Diagnosis, Classification, Prognosis, or Treatment Outcome Prediction in Female Breast Cancer: A Systematic Review. Journal of Pathology Informatics, 15: 100348.

[8] Hermans G, Casaer M, Clerckx B, et al., 2013, Effect of Tolerating Macronutrient Deficit on the Development of

Intensive-Care Unit Acquired Weakness: A Subanalysis of the EPaNIC Trial. Lancet Respiratory Medicine, 1(8): 621–629.
[9] Oddy C, Zhang J, Morley J, et al., 2024, Promising Algorithms to Perilous Applications: A Systematic Review of Risk Stratification Tools for Predicting Healthcare Utilisation. BMJ Health & Care Informatics, 31(1): e101065.
[10] Yang Z, Wang X, Wang F, et al., 2022, A Systematic Review and Meta-Analysis of Risk Factors for Intensive Care Unit Acquired Weakness. Medicine (Baltimore), 101(43): e31405.
[11] Tortuyaux R, Davion J, Jourdain M, 2022, Intensive Care Unit-Acquired Weakness: Questions the Clinician Should Ask. Revue Neurologique, 178(1–2): 84–92.
[12] Fan E, Cheek F, Chlan L, et al., 2014, An Official American Thoracic Society Clinical Practice Guideline: The Diagnosis of Intensive Care Unit-Acquired Weakness in Adults. American Journal of Respiratory and Critical Care Medicine, 190(12): 1437–1446.
[13] De Jonghe B, Sharshar T, Lefaucheur J, et al., 2002, Paresis Acquired in the Intensive Care Unit: A Prospective Multicenter Study. JAMA, 288(22): 2859–2867.
[14] Zorowitz R, 2016, ICU-Acquired Weakness: A Rehabilitation Perspective of Diagnosis, Treatment, and Functional Management. Chest, 150(4): 966–971.
[15] Wang W, Xu C, Ma X, et al., 2020, Intensive Care Unit-Acquired Weakness: A Review of Recent Progress with a Look Toward the Future. Frontiers in Medicine, 7: 559789.
[16] Shabana T, Anis S, Ibrahim D, 2021, Association between Thyroid Dysfunction and Intensive Care Unit-Acquired Weakness: A Case-Control Study. Critical Care Research and Practice, 2021: 8889036.
[17] Dres M, Jung B, Molinari N, et al., 2019, Respective Contribution of Intensive Care Unit-Acquired Limb Muscle and Severe Diaphragm Weakness on Weaning Outcome and Mortality: A Post Hoc Analysis of Two Cohorts. Critical Care, 23(1): 370.
[18] Brunello A, Haenggi M, Wigger O, et al., 2010, Usefulness of a Clinical Diagnosis of ICU-Acquired Paresis to Predict Outcome in Patients with SIRS and Acute Respiratory Failure. Intensive Care Medicine, 36(1): 66–74.
[19] Dünser M, Hasibeder W, 2009, Sympathetic Overstimulation During Critical Illness: Adverse Effects of Adrenergic Stress. Journal of Intensive Care Medicine, 24(5): 293–316.
[20] Wei X, Wang Z, Liao X, et al., 2019, Role of Neuromuscular Blocking Agents in Acute Respiratory Distress Syndrome: An Updated Meta-Analysis of Randomized Controlled Trials. Frontiers in Pharmacology, 10: 1637.
[21] Demirjian S, Teo B, Guzman J, et al., 2011, Hypophosphatemia During Continuous Hemodialysis Is Associated With Prolonged Respiratory Failure in Patients with Acute Kidney Injury. Nephrology Dialysis Transplantation, 26(11): 3508–3514.
[22] Ruo Y, Jia J, Meng T, et al., 2024, Optimal Timing for Early Mobilization Initiatives in Intensive Care Unit Patients: A Systematic Review and Network Meta-Analysis. Intensive and Critical Care Nursing, 82: 103607.
[23] Wang B, He X, Tian S, et al., 2022, Influence of Early Multidisciplinary Collaboration on Prevention of ICU-Acquired Weakness in Critically Ill Patients. Disease Markers, 2022: 3823368.
[24] Othman S, Elbiaa M, Mansour E, et al., 2024, Effect of Neuromuscular Electrical Stimulation and Early Physical Activity on ICU-Acquired Weakness in Mechanically Ventilated Patients: A Randomized Controlled Trial. Nursing in Critical Care, 29(3): 584–596.
[25] Perme C, Chandrashekar R, 2009, Early Mobility and Walking Program for Patients in Intensive Care Units: Creating a Standard of Care. American Journal of Critical Care, 18(3): 212–221.
[26] Vincent J, Shehabi Y, Walsh T, et al., 2016, Comfort and Patient-Centred Care Without Excessive Sedation: The

eCASH Concept. Intensive Care Medicine, 42(6): 962–971.

[27] Yang T, Li Z, Jiang L, et al., 2018, Corticosteroid Use and Intensive Care Unit-Acquired Weakness: A Systematic Review and Meta-Analysis. Critical Care, 22(1): 187.

[28] Hermans G, Van den Berghe G, 2015, Clinical Review: Intensive Care Unit Acquired Weakness. Critical Care, 19(1): 274.

[29] Calvani R, Joseph A, Adhihetty P, et al., 2013, Mitochondrial Pathways in Sarcopenia of Aging and Disuse Muscle Atrophy. Biological Chemistry, 394(3): 393–414.

[30] Ma H, Bandos A, Gur D, 2015, On the Use of Partial Area Under the ROC Curve for Comparison of Two Diagnostic Tests. Biometrical Journal, 57(2): 304–320.