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ORIGINAL

PREDICTIVE VALUE OF CURB-65 AND QSOFA SCORES FOR MORTALITY RISK: IMPLICATIONS FOR PHYSICAL RECOVERY AND REHABILITATION IN PATIENTS WITH PNEUMOCYSTIS CARINII PNEUMONIA AND IMMUNODEFICIENCY

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ABSTRACT

Purpose: This study aims to assess the clinical predictive value of the CURB-65 and qSOFA scores for mortality risk in patients with acquired immunodeficiency syndrome (AIDS) and Pneumocystis Carinii Pneumonia (PCP), with an emphasis on the implications for physical recovery, rehabilitation, and overall functional outcomes. The study also compares the predictive efficacy of these scores and evaluates the role of additional biomarkers in improving prognostic accuracy. **Methods:** A total of 120 patients with AIDS and PCP admitted to Beijing Youan Hospital, affiliated with Capital Medical University, from January to December 2022, were included. Patients were categorized into survival (n=85) and death (n=35) groups based on prognosis. Clinical data collected included demographics, hospitalization duration, tracheal intubation status, mechanical ventilation duration, CD4+ T lymphocyte count, WBC, CRP, PCT, GCS score, and HRCT findings. CURB-65, qSOFA, and HRCT scores were calculated, and logistic regression analysis identified independent risk factors for mortality. Receiver operating characteristic (ROC) curve analysis evaluated the predictive accuracy of individual and combined indicators. **Results:** The death group exhibited higher rates of tracheal intubation, mechanical ventilation duration, WBC, CRP, PCT, CURB-65, qSOFA, and HRCT scores, with lower CD4+ T lymphocyte counts ($P < 0.05$). WBC, CURB-65 score, qSOFA score, and HRCT score were identified as independent

predictors of mortality risk ($P < 0.05$). Predictive performance was higher for the CURB-65 score (AUC 0.913, $P < 0.001$) than for the qSOFA score (AUC 0.850, $P < 0.001$). Combined indicators (CURB-65 + HRCT + WBC) further improved predictive accuracy (AUC 0.958, $P < 0.001$) compared to qSOFA + HRCT + WBC (AUC 0.926, $P < 0.001$). **Conclusions:** The CURB-65 score, qSOFA score, and associated biomarkers (WBC and HRCT) provide significant predictive value for mortality risk in AIDS patients with PCP. The CURB-65 score demonstrated superior individual predictive performance, while CURB-65 + HRCT + WBC offered the highest accuracy in combined assessments. These findings underscore the potential for leveraging these prognostic tools to design targeted rehabilitation strategies and optimize recovery outcomes, particularly for patients aiming to regain physical functionality and engage in rehabilitation programs. Further research is recommended to integrate these tools into multidisciplinary care models that prioritize both survival and functional recovery.

KEYWORDS: Acquired Immunodeficiency Syndrome; Pneumocystis Carinii Pneumonia; Scores; Risk Factors; Prognosis

1. INTRODUCTION

Acquired Immunodeficiency Syndrome (AIDS) remains a significant global health challenge, often accompanied by life-threatening opportunistic infections such as Pneumocystis Carinii Pneumonia (PCP). PCP is a severe pulmonary condition that poses a high risk of mortality, particularly in immunocompromised individuals, due to its rapid progression and systemic complications. Effective prognostic tools are essential for early risk stratification, guiding clinical decision-making, and optimizing patient outcomes. This is particularly important for individuals who aim to achieve functional recovery and reintegrate into physical activities or rehabilitation programs. The CURB-65 (Confusion, Urea, Respiratory Rate, Blood Pressure, and Age ≥ 65 years) and qSOFA (quick Sequential Organ Failure Assessment) scores are widely used clinical tools for predicting mortality in various infectious diseases, including sepsis and community-acquired pneumonia. These scores integrate key clinical parameters to assess disease severity and guide therapeutic interventions. However, their predictive accuracy and clinical utility in AIDS patients with PCP remain underexplored. Additionally, biomarkers such as white blood cell (WBC) count, C-reactive protein (CRP), procalcitonin (PCT), and imaging findings from high-resolution computed tomography (HRCT) can provide valuable supplementary information, potentially enhancing the predictive power of these scoring systems. For patients recovering from severe infections like PCP, early identification of mortality risk is critical not only for survival but also for the timely initiation of multidisciplinary rehabilitation strategies. Prolonged hospitalization and systemic inflammation in such

conditions often lead to deconditioning, muscle wasting, and reduced physical performance. Integrating robust prognostic tools with personalized rehabilitation programs can support better functional recovery, particularly in patients seeking to regain mobility and physical activity. This study aims to evaluate the clinical predictive value of the CURB-65 and qSOFA scores in assessing mortality risk in AIDS patients with PCP. By analyzing their individual and combined performance with biomarkers and HRCT findings, this research seeks to identify optimal predictive models that can inform both acute care and long-term rehabilitation strategies. The findings will contribute to developing comprehensive care plans that prioritize survival, recovery, and the resumption of physical functionality, aligning with the principles of sports medicine and rehabilitation sciences. AIDS patients have low immune function and are prone to various opportunistic infections. Among them, PCP is the most common, serious and highly fatal respiratory system infections. Therefore, early identification and assessment of the severity of the condition, prediction of disease progression and outcome, guidance for clinical diagnosis and treatment plan selection are particularly important. This study aims to explore the clinical predictive value of CURB-65 score and q-SOFA score for the risk of death in patients with AIDS combined with PCP and to analyze and compare the predictive efficacy of the two scores in order to better assist clinical diagnosis and treatment.

2. Materials and Methods

2.1. Data Collection

A total of 120 patients with AIDS combined with PCP who were admitted to Beijing Youan Hospital affiliated to Capital Medical University from January 2022 to December 2022 were selected as the study subjects.

Inclusion criteria: aged ≥ 18 years; HIV-1/2 antibody positive; a microbiological diagnosis of PCP that the detection of *Pneumocystis carinii* cysts or trophozoites in sputum, bronchoalveolar lavage fluid or lung biopsy tissue.

Exclusion criteria: patients with concomitant infections in other parts or infections with other pathogens; those with incomplete clinical data that affect scoring; those whose prognosis judgment is affected by patient refusal or abandonment of treatment.

The relevant clinical data of the participates including gender, age, length of hospital stay, whether they underwent tracheal intubation, duration of mechanical ventilation, CD4⁺T lymphocyte count, WBC, CRP, PCT, consciousness status, GCS score, BUN, respiratory rate, blood pressure and HRCT were collected through the electronic medical record system. According

to the prognosis outcome, the participants were divided into survival group and death group. Based on the data from the first day of admission, CURB-65 score, q-SOFA score and HRCT score were calculated. Three observation planes of the upper edge of the aortic arch, tracheal prominence and 1cm above the right diaphragm were selected to represent the upper, middle and lower lung fields respectively for the HRCT score. Then the percentages of ground-glass opacity, reticular shadow and honeycomb shadow in each plane were scored semi-quantitatively as follows: 0 point for no change, 1 point for 1-25%, 2 points for 26-50%, 3 points for 51-75% and 4 points for 76%-100%. The cumulative points of each plane was used to calculate the HRCT score.

2.2. Statistical Analysis

Normally distributed continuous variables were presented as means \pm standard deviations (mean \pm SD) and statistical comparison between two groups were performed by two-tailed student's t-test. The non-normally distributed continuous variables were presented as median and interquartile range [IQR (P25, P75)] and the Mann-Whitney *U* test was used for the comparison between the two groups. Categorical variables were depicted as numbers and percentages [*n* (%)] and analyzed with chi-squared test or Fisher's exact test.

Variables with statistical differences between the survival group and death group were analyzed by univariate logistic regression analysis and variables with statistical significance in univariate logistic regression analysis were further analyzed by multivariate logistic regression analysis to determine the independent risk factors of mortality in AIDS patients with PCP. The clinical predictive value of variables for the mortality risk of AIDS patients with PCP was assessed using the area under the ROC curve [AUC, with 95% confidence interval (CI)]. A two-sided *p*-value of <0.05 was considered statistically significant.

3. Results

3.1. Comparison of Clinical Data between the Survival Group and Death Group

A total of 120 participants were included in this study, with 85 in the survival group (70.8%) and 35 in the death group (29.2%). There was no statistically significant difference between the two groups in terms of gender, age and length of hospital stay ($P>0.05$). However, the death group had higher rates of tracheal intubation, mechanical ventilation duration, WBC, CRP, PCT, CURB-65 score, q-SOFA score and HRCT score than the survival group ($P<0.05$), while the CD4⁺T lymphocyte count was lower in the death group than in the survival group ($P<0.05$) (Table 1).

Table 1: Characteristics of Survival Group and Death Group

VARIABLES	SURVIVAL GROUP (N=85)	DEATH GROUP (N=35)	T/Z/ χ^2	P
AGE(YEARS)	43.61±13.61	49.26±14.76	-1.947	0.056
MALE (N, %)	79(92.9)	34(97.1)	0.797	0.372
TRACHEAL INTUBATION (N, %)	0(0.0)	30(85.7)	97.143	<0.001
DURATION OF MECHANICAL VENTILATION(DAYS)	0(0,0)	6(2,12.5)	-9.682	<0.001
DURATION OF HOSPITALIZATION(DAYS)	14(11,20)	15(5.5,23)	-0.659	0.51
CD4+T LYMPHOCYTE(/UL)	34(19,58)	17(6.5,29)	-3.006	0.003
WBC($\times 10^9/L$)	5.06(3.48,7.59)	8.15(4.99,11.7)	-3.014	0.003
CRP(MG/L)	34.42(10.52,67.19)	61.44(30.24,91.54)	-2.338	0.019
PCT(NG/ML)	0.05(0.05,0.2)	0.35(0.12,3.21)	-5.642	<0.001
CURB-65 SCORE(POINTS)	0(0,0)	2(1.5,3)	-7.929	<0.001
QSOFA SCORE(POINTS)	0(0,0)	1(1,2)	-6.853	<0.001
HRCT SCORE(POINTS)	7(4,9)	10(6,12)	-4.208	<0.001

3.2. Independent Risk Factor Analysis for Mortality in AIDS Combined with PCP

Indicators with statistically significant differences between the survival group and death group, including WBC, CURB-65 score, qSOFA score and HRCT score were included in a univariable logistic regression analysis. Variables with significant differences ($P < 0.05$) were further analyzed using multivariable logistic regression. The results showed that WBC, CURB-65 score, qSOFA score and HRCT score were all independent risk factors for mortality in AIDS combined with PCP ($P < 0.05$) (Table 2 and Table 3).

Table 2: Univariate Logistic Regression Analysis of Independent Risk Factors of Mortality Risk for AIDS Combined with PCP

VARIABLES	OR (95%CI)	P
TRACHEAL INTUBATION (N, %)	2.75E+10(0~.)	0.997
DURATION OF MECHANICAL VENTILATION(DAYS)	3.50E+07(0~.)	0.983
CD4+T LYMPHOCYTE(/UL)	0.994(0.986~1.003)	0.186
WBC($\times 10^9/L$)	1.152(1.055~1.258)	0.002
CRP(MG/L)	1.008(0.999~1.016)	0.071
PCT(NG/ML)	1.103(0.997~1.221)	0.058
CURB-65 SCORE(POINTS)	14.005(5.223~37.558)	<0.001
QSOFA SCORE(POINTS)	11.024(4.464~27.223)	<0.001
HRCT SCORE(POINTS)	1.371(1.173~1.602)	<0.001

Table 3: Multivariate Logistic Regression Analysis of Independent Risk Factors of Mortality Risk for AIDS Combined with PCP

VARIABLES	AUC	95%CI	THE BEST CUT-OFF VALUE	SENSITIVITY (%)	SPECIFICITY (%)	P
CURB-65	0.913	0.841~0.984	>1	74.29	100	<0.001
QSOFA	0.850	0.765~0.936	>0	82.86	76.47	<0.001
CURB-65+HRCT+WBC	0.958	0.914~1.000	>0.49	85.71	97.65	<0.001
QSOFA+HRCT+WBC	0.926	0.875~0.977	>0.15	94.29	80	<0.001

3.3. Clinical predictive value analysis of independent risk factors for death in AIDS combined with PCP

ROC curves showed that when predicting the risk of death in AIDS combined with PCP patients, the AUC value of CURB-65 score was 0.913(optimal cutoff value >1 point, sensitivity 74.29%,specificity 100%);the AUC value of qSOFA score was 0.850(optimal cutoff value >0 points, sensitivity 82.86%,specificity 76.47%);the combined AUC value of CURB-65 score, HRCT score and WBC was 0.958(optimal cutoff value > 0.49 points, sensitivity 85.71%,specificity 97.65%);the combined AUC value of qSOFA score, HRCT score and WBC was 0.926(optimal cutoff value > 0.15 points, sensitivity 94.29%,specificity 80%). ROC curve analysis revealed that for a single indicator, the predictive value of CURB-65 score(AUC 0.913, $P<0.001$) was superior to that of qSOFA score(AUC 0.850, $P<0.001$);for combined indicators, the predictive value of CURB-65+HRCT+WBC(AUC 0.958, $P<0.001$) was superior to that of qSOFA+HRCT+WBC(AUC 0.926, $P<0.001$)(Table 4, Fig.1).

Table 4: Predictive Value of Independent Risk Factors of Mortality Risk for AIDS Combined with PCP

VARIABLES	B	SE	WALD χ^2	P	OR (95%CI)
WBC($\times 10^9/L$)	0.222	0.098	5.103	0.024	1.248(1.030~1.513)
CURB-65 SCORE(POINTS)	3.202	0.852	14.121	<0.001	24.586(4.627~130.626)
QSOFA SCORE(POINTS)	2.917	1.024	8.11	0.004	18.477(2.483~137.521)
HRCT SCORE(POINTS)	0.374	0.175	4.586	0.032	1.453(1.032~2.046)
CONSTANT	-10.305	2.695	14.616	<0.001	0

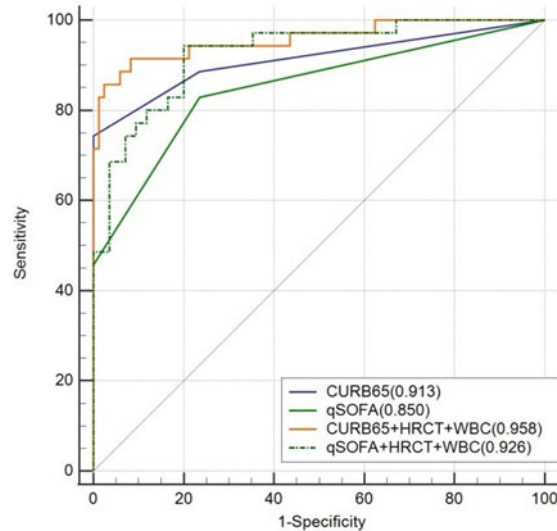


Figure 1: ROC Curve of Independent Risk Factors of Mortality Risk Predicting AIDS Combined with PCP

4. Discussion

According to statistics in 2020, the total number of AIDS patients worldwide reached 37.7 million and it is increasing at a rate of 1.5 million new cases per year (Chinese Center for Disease Control and Prevention, 2021; WHO, 2021). The total number of AIDS patients in China has exceeded 850,000 people (Zheng, 2018). Although most AIDS patients can achieve HIV viral load negativity and CD4⁺T lymphocyte counts greater than 200 cells/ul after strict anti-retroviral therapy, they still cannot prevent various opportunistic infections or even malignant tumors that shorten their survival time. PCP is an opportunistic infection of the respiratory system with extremely high incidence and mortality rate of AIDS patients (Buchacz et al., 2010; Elango et al., 2022) and its incidence rate is as high as 22.4% (Xiao et al., 2013). The overall mortality rate is 65% and even higher at 84% for those who require mechanical ventilation or admission to the ICU due to respiratory failure (Truong & Ashurst, 2023). Therefore, it is very important to use objective digital evaluation indicators to early warning and determine the outcome of AIDS combined with PCP patients to guide clinical diagnosis and treatment. A retrospective study of Beijing Ditan Hospital found that the CURB-65 score, PSI score and APACHE II score are independent risk factors for predicting the 180-day mortality rate of AIDS combined with PCP patients (Wang et al., 2020), but the PSI score and APACHE II score involve multiple indicators and complex calculations which limit its clinical application. The qSOFA scoring system is simple and easy to calculate and it can quickly evaluate the severity and prognosis of diseases. However, there is currently no relevant research on using qSOFA score to assess the risk of death in AIDS combined with PCP patients. This study aims to explore the clinical predictive value of CURB-65 score and qSOFA score for

the death risk of AIDS combined with PCP patients and compare the prediction efficiency of both scores to better assist clinical diagnosis and treatment. This study conducted statistical analysis on the clinical data of 120 AIDS patients with PCP and found that WBC count, CURB-65 score, qSOFA score and HRCT score were independent risk factors for death in AIDS patients with PCP ($P < 0.05$). The WBC count can reflect the degree of systemic infection when the patient is admitted to the hospital. The CURB-65 score includes consciousness disorders, blood urea nitrogen > 7 mmol/L, respiratory rate ≥ 30 times/min, systolic blood pressure < 90 mmHg or diastolic blood pressure ≤ 60 mmHg, age ≥ 65 years, for a total of five parameters. Each parameter is assigned 1 point from aspects including the central nervous system, renal system, respiratory system, circulatory system and basic age. This score is used to evaluate the severity of community acquired pneumonia comprehensively. Scores of 0-1 indicate low-risk and only require outpatient treatment; scores of 2 indicate short-term hospitalization; scores of 3-5 indicate hospitalization or even ICU treatment. However, the data analysis of this study shows that the best cutoff value of CURB-65 score for predicting the risk of death in AIDS patients with PCP is > 1 point, with a sensitivity of 74.29% and specificity of 100%, which indicates that CURB-65 score has a wider range of application, sensitivity and higher specificity for the immunocompromised population such as the AIDS patients. The qSOFA score includes Glasgow Coma Scale (GCS) score < 13 points, respiratory rate ≥ 22 times/min and systolic blood pressure ≤ 100 mmHg. Each parameter is assigned 1 point from aspects including the central nervous system, respiratory system and circulatory system. The score indicates suspicion of sepsis and requires ICU treatment if the total score is > 2 points. Combined with the results of this study, the best cutoff value for predicting the risk of death in AIDS patients with PCP using the qSOFA score is > 0 points, with a sensitivity of 82.86% and specificity of 76.47%, indicating that the presence of any one of the above symptoms suggests a risk of severe infection in AIDS patients with PCP. The HRCT score is mostly used for semi-quantitative assessment of the severity of interstitial lung disease (Mononen et al., 2021). Since pneumocystis mostly adheres to the surface of type I alveolar epithelial cells (Thomas Jr & Limper, 2004), causing lung injury and gas exchange disorders due to host inflammatory reactions, it usually presents as diffuse ground-glass opacities on imaging, sometimes with mosaic signs and irregular gas cavities, and also belongs to the category of interstitial pneumonia (Akiyama et al., 2019; Kunihiro et al., 2019; Kunihiro et al., 2015; Takaki et al., 2023). Therefore, we attempted to explore the correlation between HRCT score and the risk of death in AIDS patients with PCP from the perspective of imaging and found that the HRCT score was also an independent risk factor for death in AIDS patients with PCP, providing new research ideas for prognostic evaluation of this disease. A ROC curve analysis was further conducted to compare the difference between CURB-65 score and qSOFA score for the predictive value of death risk of AIDS combined with PCP.

The results showed that the AUC of CURB-65 score was 0.913 while the AUC of qSOFA score was 0.850, indicating a better predictive efficacy of CURB-65 score. This may be due to the fact that CURB-65 score has more parameters such as kidney function and age classification than qSOFA score, making it a more comprehensive and objective assessment of the patients overall situation. Therefore, in clinical practice, using the CURB-65 score for rapid and convenient prediction of the possible disease progression of AIDS patients with PCP at initial admission can guide the early use of glucocorticoids or antifungal drugs such as caspofungin on top of the basic treatment of sulfamethoxazole-trimethoprim, which can greatly improve the prognosis and survival rate of AIDS patients with PCP. Because literature has shown that the extent of ground glass opacities on chest HRCT is related to the prognosis of PCP and this study confirmed that HRCT score is an independent risk factor for AIDS combined with PCP mortality risk, it was used in combination with CURB-65 score, qSOFA score and WBC to test for predictive efficacy. The results showed that the AUC of CURB-65+HRCT+WBC was 0.958 while the AUC of qSOFA+HRCT+WBC was 0.926, indicating that the predictive value of CURB-65+HRCT+WBC was better. CURB-65+HRCT+WBC includes digital quantitative evaluation of multi-system severity of diseases, chest imaging severity and infection indicators, providing a better predictive efficacy and potentially serving as a new predictive model for assessing AIDS combined with PCP mortality risk. However, further research data is needed for validation. This study is a single-center retrospective study with a relatively small sample size and the results may have some limitations. A multi-center study is needed to include more cases to expand the sample size in order to better support the conclusions of this study.

5. Conclusion

WBC, CURB-65 score, qSOFA score and HRCT score are all independent risk factors for mortality risk of AIDS with PCP. Regarding a single indicator, the clinical predictive value of CURB-65 score is better than that of qSOFA score for the death risk of AIDS combined with PCP. As for combined indicators, the combination of CURB-65+HRCT+WBC is better than qSOFA+HRCT+WBC. With the high mortality rate of AIDS patients with PCP, early and accurate assessment of disease severity and prompt initiation of treatment is crucial. Due to the advantages of easy data access, convenient calculation and high predictive value, CURB-65 score and CURB-65+HRCT+WBC can be widely used in clinical practice to assess the severity of disease and prognosis of AIDS patients with PCP, given the high mortality rate associated with this condition.

Author Contribution

SW studied conception and design, collected and analyzed the clinical data, and drafted the manuscript; YX read the scientific literature, collected the

clinical data.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Beijing Youan Hospital Capital Medical University. All experiments were performed in accordance with relevant guidelines and regulations (e.g., Declaration of Helsinki), and informed consent was obtained from all subjects and/or their legal guardian(s).

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