Utility of the PITT Bacteremia Score for Predicting Mortality in CRE Colonized and Infected Patients

Abstract

Background :The Pitt Bacteremia Score (PBS) is used to predict 14-day inpatient mortality in bloodstream infections. This study evaluates whether PBS can also predict mortality in ICU patients colonized or infected with Carbapenem -resistant *Enterobacterales* (CRE).
Methods: ICU patients with CRE were selected, and each PBS component was individually assessed. Outcomes were noted after 14 days, and a PBS cutoff score for mortality prediction was analyzed.
Results: Of 30 patients, 26 (86%) expired and 4 (14%) survived. A PBS cutoff of ≥4 was associated with a significant increase in mortality.
Conclusions: PBS ≥4 may be a valuable predictor of mortality in CRE-infected and colonized ICU patients."

Keywords: Pitt bacteremia score, Carbapenem-resistant Entrobacteriacae, Mortality score ,Risk score

Introduction

The global rise in multidrug-resistant Enterobacteriaceae infections in recent years has become a major public health crisis (1). CRE are one of the most threatening pathogens affecting severely ill patients admitted in intensive care units (ICUs). Underlying comorbid conditions in these patients increases the mortality rate among these patients (2–4) CRE colonization in these patients is associated with increased risk of CRE infection.(5) . Predicting outcomes in these patients could facilitate more aggressive management, with easily identifiable and measurable predictors proving especially useful. An easily identifiable and measurable predictor may prove to be even more useful. [6] Thus a valid, reliable, and measurable indicator of acute severity of illness is required to stratify patients by baseline risk of mortality.

Several recent studies have introduced new risk assessment tools tailored specifically for patients diagnosed with CRE infections. The INCREMENT-CPE score (ICS) was initially designed to predict mortality within 14 days among individuals with carbapenemase-producing Enterobacteriaceae (CPE) bacteremia. Subsequent modifications extended its applicability to predicting 30-day mortality in both bacteremic and non-bacteremic CPE infections. Another notable tool is the Pitt bacteremia score (PBS), along with its simplified version, the qPitt, which

have recently been validated across a large cohort of patients affected by both bacteremic and non-bacteremic CRE infections [3,4,6,].

PBS is a scoring system that predicts the 14-day mortality of a patient in a clinical observation based on the data of physical examination. PBS has fewest parameters and is easiest to calculate.[7] It assess the severity of acute illness based on patient specific variables thus it has major advantages over other scores like APACHE and SOFA[8]. The absence of laboratory results allows for the immediate application of the PBS at the bedside, without delays for venous puncture and the subsequent receipt of laboratory results. PBS is generally used for BSI infections [3] but there are limited studies on its validation in non-bacteremic infections (PITT). consequently, there is uncertainty regarding the performance of these risk scores in the context of the current era of more effective and safer antibiotic therapies
There are very few studies predicting the outcome of CRE patients using the Pitt's bacteremia score and as far as our knowledge no study from India predicting the mortality in CRE colonized and infected patients using the Pitt's Bacteremia score.

OBJECTIVES

To evaluate the utility of Pitt bacteremia score for predicting the mortality in CRE colonized infected patients.
To assess the contribution of each component of the PBS to predict the mortality in subjects

Methodology

Type of study /Study design - Cross sectional - Prospective observational study
Study population/ participants - Patients above 18 years of age admitted to the ICUs in a northern central India's tertiary care center.

Consent - Informed written consent is obtained from all participants, or their attendees if the participant is unconscious

Sample Method and sample size -

All patients under the inclusion criteria during the study period are included.

Inclusion criteria -

1. Patients admitted in ICU and colonized or infected with CRE

Exclusion criteria -

1. Outdoor Patients
2. Patients not willing to enroll in the study
3. Pregnant females
4. children less than 18 years of age

Methods –

The patients admitted in the ICUs are enrolled in the study after obtaining proper informed consent.

Detailed clinical history (including demographic and personal history – to identify different risk factors) and clinical examination will be done. Rectal swabs were collected from patients admitted in ICU and will be cultured on MacConkey agar for colonization by GNR. Carbapenem resistance will be detected by kirby bauer disc diffusion using meropenem, imipenem, ertapenem disc.

For patients showing signs of infections, respective samples are sent to the microbiology laboratory. Patient's infected with carbapenem resistant Enterobacteriaceae will be included in the study.

Pitt Bacteremia Score : For each patient, baseline is defined as the date of collection of the CRE positive culture that will be included in this analysis. The outcome of interest was 14-day all-cause inpatient mortality, measured from baseline. The PBS is calculated for each patient at baseline pitt bacteremia. The hypotension, mechanical ventilation, mental status, and maximum temperature parameters of the PBS are measured on the baseline date. For each variable, the worst reading on the calendar day of the index culture will be recorded. Cardiac arrest will be considered present if it occurred on the baseline date or within the previous 48 hours

List 1-Weightage of each variable in PBS Scoring

Variable	Weight
Hypotension	2
Mechanical ventilation	2
Cardiac arrest	4
Mental status	
Disoriented	1
Stuporous	2
Comatose	4
Maximum temperature(referent: 36.1–38.9)	
35.1–36.0 or 39.0–39.9	1
≤35.0 or ≥40.0	2

IMPLICATIONS

The prediction scores may help in feasible and rapid triaging of patients with CRE infections Early identification of high-risk patients in low resource setting will help in timely and better management of patients .The prediction and standardized scoring system helps to compare analysis of different populations

RESULTS

Study Population and 14-Day Inpatient Mortality

Patient overview

A total of 42 Carbapenem-resistant Enterobacteriaceae–positive Culture were collected from the ICU as clinical samples and Rectal swabs out of which 28 had positive CRE positive cultures from BAL and Tracheal sample and rectal swabs while 2 patients had no growth from Tracheal sample but showed CRE in rectal swab screening. Flow chart 1

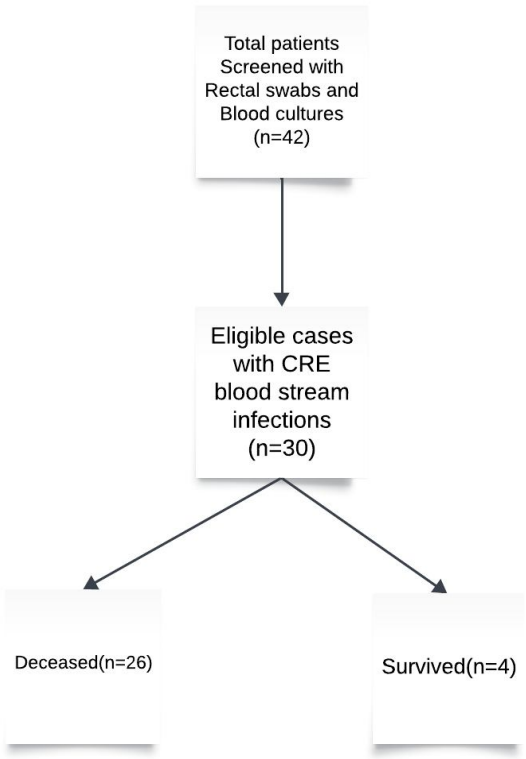


Fig 1- Study protocol

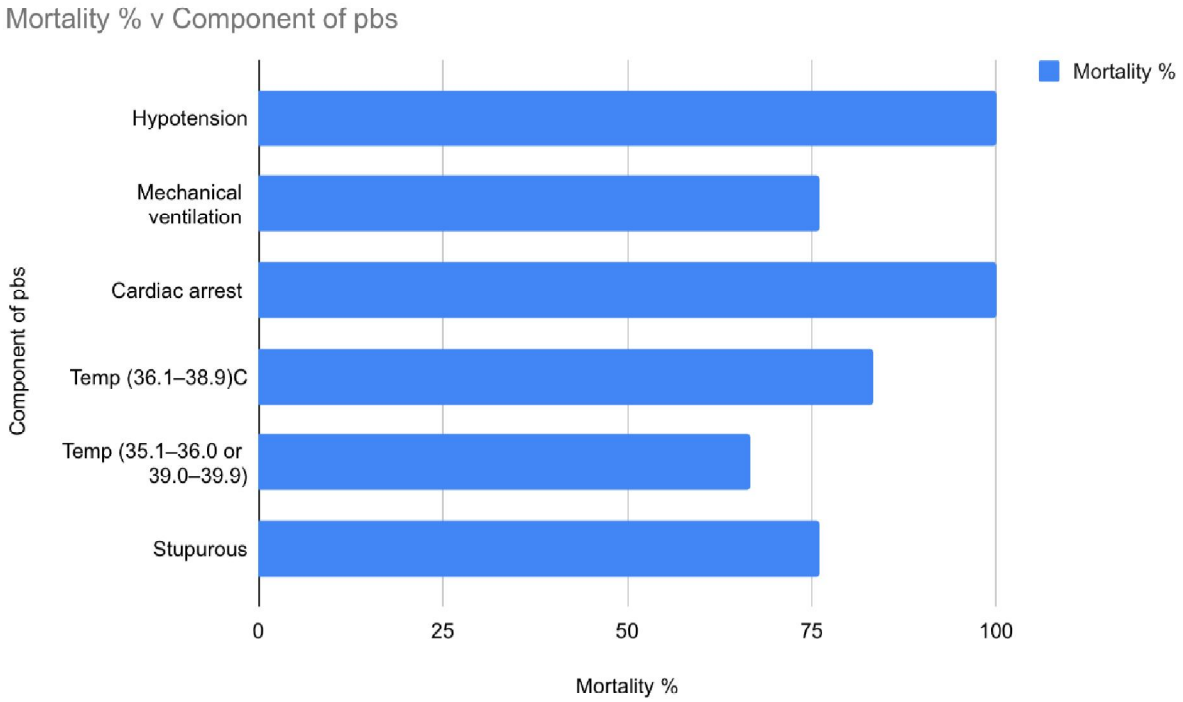
Contribution of individual component of PBS In Mortality

When analyzed each component of PBS had a significant effect on mortality. All the patients who had hypertension (n=12) expired within 14 days. Cardiac arrest was significantly associated with mortality with 100% mortality

Table 2. Contribution of individual component of PBS In Mortality

Characteristic	TOTAL	Died	SURVIVED
Hypotension	12/30(40%)	12	0
Mechanical ventilation	30/30(100%)	23	7
Cardiac arrest	4/30(13.3%)	4	0
Maximum temperature (°C)			
36.1–38.9	18/30(60%)	15	3
35.1–36.0 or 39.0–39.9	12/30(40%)	8	4
≤35.0 or ≥40.0	0	0	0
Mental status			
Normal	0	0	0
Disoriented	0	0	0
Stuporous	30/30(100%)	23	7
Comatose	0	0	0

Fig 2- Contribution of individual component of PBS In Mortality



K. pneumoniae was isolated from 24 out of the 30 patients. From. The remaining 6 isolates were Enterobacter sp. (4), Escherichia coli (2)

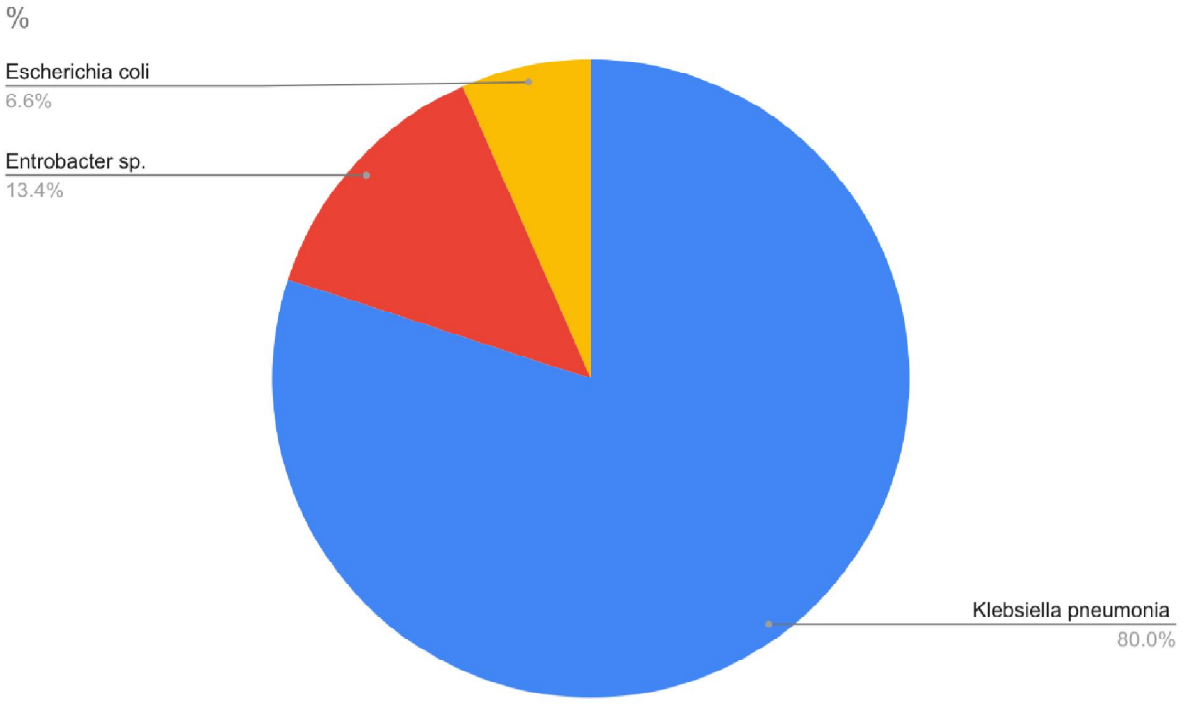


Fig 3- Pie chart showing mortality percentage

The most appropriate cutoff for the PBS was found to be when the score increased from 3 to 4, mortality increased markedly and continued in an increasing trend as the PBS increased above 4. The most appropriate cutoff level was <4 vs ≥4

Table 1- PBS score sheet

PBS SCORE	EXPIRED	DISCHARGED
1	0	0
2	0	0
3	0	2(100%)
4	1(16.6%)	5(84%)
5	9(100%)	0
6	9(100%)	0
>=7	4(100%)	0

Table 2- Coordinates of the Curve

Test Result Variable(s): PB Score		
Positive if Greater Than or Equal To	Sensitivity	1 - Specificity
2.00	1.000	1.000
3.50	1.000	.714
4.50	.955	.000
5.50	.545	.000
6.50	.182	.000
8.00	.000	.000

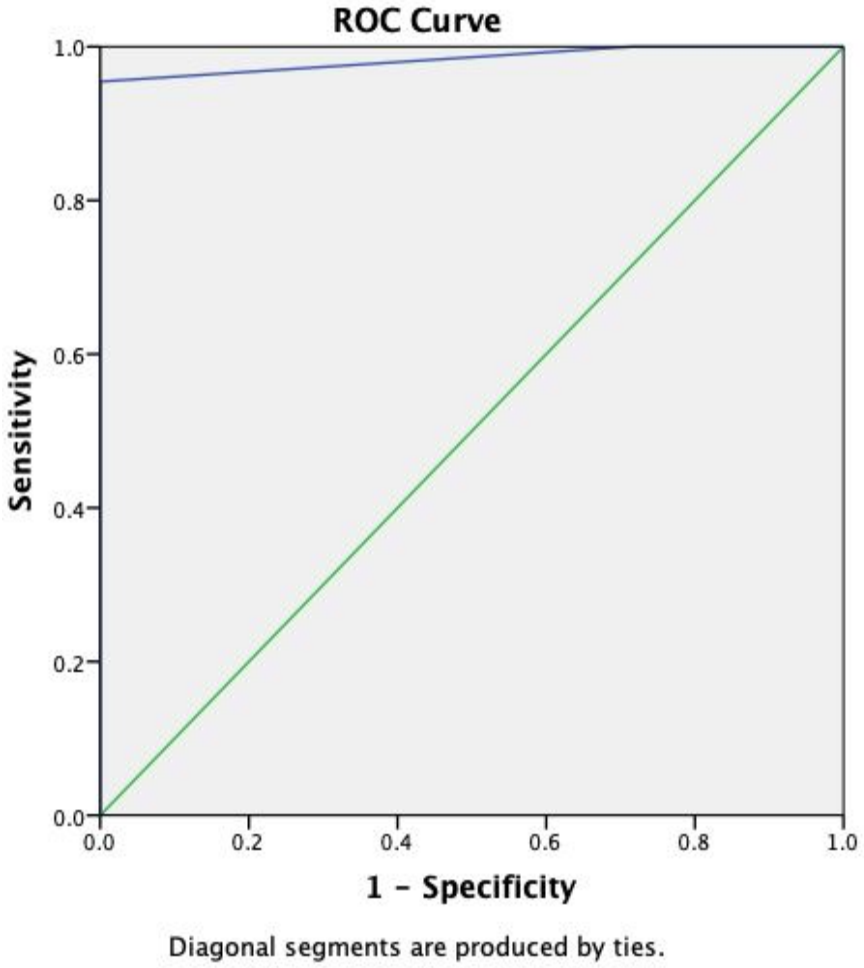


Fig 4 Sensitivity vs Specificity diagram

Antimicrobial susceptibility testing results

Antibiotic sensitivity of the positive cultures (Resistant to meropenem) showed maximum resistance to Gentamicin 73% followed by Amikacin 53%. Graph 1

Pit	Amc	Ak	Le	Cot	Ctr	At	Mrp
53	73	53	53	33	26	3	100

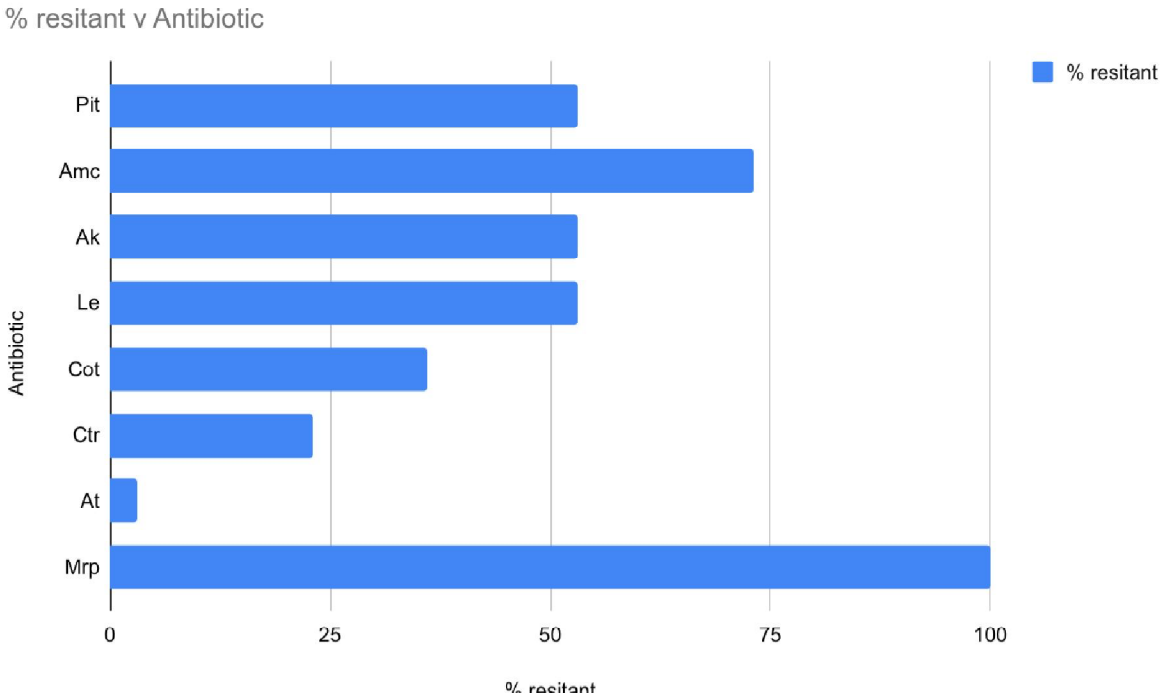


Fig 5 Graph 1- Antimicrobial susceptibility testing results

Discussion:

Our study aimed to evaluate the predictive utility of the Pitt Bacteremia Score (PBS) in determining mortality among critically ill patients admitted to ICUs and colonized or infected with Carbapenem-resistant Enterobacteriaceae (CRE). Our findings revealed a compelling association between elevated PBS scores and heightened mortality risk, particularly pronounced in patients exhibiting critical conditions such as hypotension, cardiac arrest, mechanical ventilation, and altered mental status (stuporous). These findings align closely with several seminal studies.

A meta-analysis by Johnson et al. (2020) supports our findings, confirming the effectiveness of PBS in predicting mortality across various infection types, including gram-negative bacterial infections. This broader validation supports PBS's applicability in ICU settings for risk assessment and clinical decision-making in critically ill patients.[9]

In a comparison of the PBS with the Sequential Organ Failure Assessment (SOFA) score in septic patients, Vincent et al. (1996) highlighted PBS's specificity in assessing bacteremia-related mortality risks, in contrast to SOFA's broader focus on organ dysfunction. This distinction underscores PBS's tailored approach in identifying high-risk patients specifically in infectious contexts.[10]

Our study extends this body of evidence by focusing explicitly on PBS's application in CRE infections, providing nuanced insights into bacteremia-related mortality risks in this challenging patient population. By identifying specific PBS components associated with increased mortality, such as hypotension and mechanical ventilation, our findings underscore the clinical relevance of PBS in guiding targeted therapeutic interventions and optimizing resource allocation in ICU settings.

Conclusion:

This study advances the understanding of PBS as a critical tool for mortality prediction in critically ill patients with CRE infections. The consistent findings across various infection types and patient populations reinforce PBS's reliability and clinical relevance in modern healthcare settings. Moving forward, further multicenter studies and prospective validations will be crucial to solidify PBS's role as a standard prognostic tool in managing antibiotic-resistant infections and improving patient outcomes.

Limitation:

Small Sample Size: Limited to patients from a single tertiary care center in northern central India, limiting generalizability. Due to small and limited sample size, very low survival rate is encountered which impacted the survival prediction of PITT score.
Study Design: Susceptible to biases and confounding factors that may influence the interpretation of PBS's predictive value. Term Outcome Focus: Primarily focused on 14-day inpatient mortality, may not capture longer-term outcomes or chronic effects of CRE infections.

Disclaimer (Artificial intelligence)

Option 1:
Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.
Option 2:
Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the

name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology
Details of the AI usage are given below:
1.
2.
3.

References

1.Grundmann, H., Livermore, D. M., Giske, C. G., Cantón, R., Rossolini, G. M., Campos, J., Vatopoulos, A., Gniadkowski, M., Toth, A., Pfeifer, Y., Jarlier, V., Carmeli, Y., & Group, C. T. C. W. (2010). Carbapenem-non-susceptible Enterobacteriaceae in Europe: conclusions from a meeting of national experts. Eurosurveillance, 15(46). https://doi.org/10.2807/ese.15.46.19711-en

2.Paterson, D. L. (2004). International Prospective Study of Klebsiella pneumoniae Bacteremia: Implications of Extended-Spectrum β-Lactamase Production in Nosocomial Infections. Annals of Internal Medicine, 140(1), 26. https://doi.org/10.7326/0003-4819-140-1-200401060-00008

3.Henderson, H., Luterbach, C. L., Cober, E., Richter, S. S., Salata, R. A., Kalayjian, R. C., Watkins, R. R., Doi, Y., Kaye, K. S., Evans, S., Fowler, V. G., Bonomo, R. A., Harris, A., Napravnik, S., & Van Duin, D. (2019). The Pitt Bacteremia Score Predicts Mortality in Nonbacteremic Infections. Clinical Infectious Diseases, 70(9), 1826–1833. https://doi.org/10.1093/cid/ciz528

4.Cano, A., Gutiérrez-Gutiérrez, B., Machuca, I., Gracia-Ahufinger, I., Pérez-Nadales, E., Causse, M., Castón, J. J., Guzman-Puche, J., Torre-Giménez, J., Kindelán, L., Martínez-Martinez, L., Rodriguez-Baño, J., & Torre-Cisneros, J. (2018). Risks of Infection and Mortality Among Patients Colonized With Klebsiella pneumoniae Carbapenemase-Producing K. pneumoniae: Validation of Scores and Proposal for Management. Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America, 66(8), 1204–1210. https://doi.org/10.1093/cid/cix991

5. Rhee, J.-Y., Kwon, K. T., Ki, H. K., Shin, S. Y., Jung, D. S., Chung, D.-R., Ha, B.-C., Peck, K. R., & Song, J.-H. (2009). SCORING SYSTEMS FOR PREDICTION OF MORTALITY IN PATIENTS WITH INTENSIVE CARE UNIT-ACQUIRED SEPSIS. Shock, 31(2), 146–150. https://doi.org/10.1097/shk.0b013e318182f98f

6.Gutiérrez-Gutiérrez, B., Salamanca, E., de Cueto, M., Hsueh, P.-R., Viale, P., Paño-Pardo, J. R., Venditti, M., Tumbarello, M., Daikos, G., Pintado, V., Doi, Y., Tuon, F. F., Karaiskos, I., Machuca, I., Schwaber, M. J., Azap, Ö. K., Souli, M., Roilides, E., Pournaras, S., & Akova, M. (2016). A Predictive Model of Mortality in Patients With Bloodstream Infections due to Carbapenemase-Producing Enterobacteriaceae. Mayo Clinic Proceedings, 91(10), 1362–1371. https://doi.org/10.1016/j.mayocp.2016.06.024

7.Feldman, C., Alanee, S., Yu, V. L., Richards, G. A., Ortqvist, A., Rello, J., Chiou, C. C. C., Chedid, M. B. F., Wagener, M. M., & Klugman, K. P. (2009). Severity of illness scoring systems in patients with bacteraemic pneumococcal pneumonia: implications for the intensive care unit care. Clinical Microbiology and Infection, 15(9), 850–857. https://doi.org/10.1111/j.1469-0691.2009.02901.x

8. Sojo-Dorado, J., López-Hernández, I., Rosso-Fernandez, C., Morales, I. M., Palacios-Baena, Z. R., Hernández-Torres, A., Merino de Lucas, E., Escolà-Vergé, L., Bereciartua, E., García-Vázquez, E., Pintado, V., Boix-Palop, L., Natera-Kindelán, C., Sorlí, L., Borrell, N., Giner-Oncina, L., Amador-Prous, C., Shaw, E., Jover-Saenz, A., & Molina, J. (2022). Effectiveness of Fosfomycin for the Treatment of Multidrug-Resistant Escherichia coli Bacteremic Urinary Tract Infections. JAMA Network Open, 5(1), e2137277. https://doi.org/10.1001/jamanetworkopen.2021.37277

9. Johnson AE, Pollard TJ, Shen L, et al. Multidrug-resistant organism infection score for predicting mortality in critically ill patients with gram-negative bacterial infection: A retrospective cohort study. Ann Intensive Care. 2020;10(1):68. doi:10.1186/s13613-020-00690-

10. Chen L, Han X, Li Y, Li M. Assessment of Mortality-Related Risk Factors and Effective Antimicrobial Regimens for Treatment of Bloodstream Infections Caused by Carbapenem-Resistant Enterobacterales. Antimicrobial Agents and Chemotherapy. 2021 Aug 17;65(9)

11.Nakada□Motokawa N, Miyazaki T, Ueda T, Yamagishi Y, Yamada K, Kawamura H, et al. Modified Pitt bacteraemia score for predicting mortality in patients with candidaemia: A multicentre seven□year retrospective study conducted in Japan. Mycoses [Internet]. 2021 Oct 23 [cited 2024 Nov 3];64(12):1498–507. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9297953/

12.María Paz Vaquero-Herrero, Ragozzino S, Fabián Castaño-Romero, María Siller-Ruiz, Rebeca Sánchez González, José Elías García-Sánchez, et al. The Pitt Bacteremia Score, Charlson Comorbidity Index and Chronic Disease Score are useful tools for the prediction of mortality in patients with *Candida* bloodstream infection. Mycoses. 2017 Aug 21;60(10):676–85.

13. Su C, Tsai I-Ting, Lai CH, Lin KH, Chen C, Hsu YC. Prediction of 30-Day Mortality Using the Quick Pitt Bacteraemia Score in Hospitalized Patients with Klebsiella pneumoniae Infection. Infection and Drug Resistance. 2023 Jul 1;Volume 16:4807

14. Value of the Pitt Bacteraemia Score to predict short-term mortality in Staphylococcus aureus bloodstream infection: a validation study. Swiss Medical Weekly. 2017 Aug 10;147(3132).

15.Al-Hasan MN, Lahr BD, Eckel-Passow JE, Baddour LM. Predictive scoring model of mortality in Gram-negative bloodstream infection. Clinical Microbiology and Infection. 2013 Oct;19(10):948–54.