



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

Areeb Shahid Rao ^{a++}, Fatima Khan ^{b#*}, Abu Nadeem ^{a†}
and Arsalan ^{a++}

^a JNMCH, AMU, India.

^b Department of Microbiology, JNMCH, AMU, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajmah/2024/v22i121135>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/127050>

Original Research Article

Received: 23/09/2024
Accepted: 26/11/2024
Published: 03/12/2024

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 *Enterobacteriales* (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.

⁺⁺ MBBS Phase III;

[#] MD Microbiology Professor;

[†] M.D, Associate Professor;

*Corresponding author: E-mail: fatimasalmanshah@gmail.com;

Cite as: Rao, Areeb Shahid, Fatima Khan, Abu Nadeem, and Arsalan. 2024. "Utility of the PITT Bacteremia Score for Predicting Mortality in CRE Colonized and Infected Patients". *Asian Journal of Medicine and Health* 22 (12):51-59. <https://doi.org/10.9734/ajmah/2024/v22i121135>.

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 Enterobacteriaceae; mortality score; risk score.

1. INTRODUCTION

The global rise in multidrug-resistant Enterobacteriaceae infections in recent years has become a major public health crisis (Grundmann et al., 2010). 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 (Paterson, 2004; Henderson et al., 2019); Cano et al., 2018) CRE colonization in these patients is associated with increased risk of CRE infection (Rhee et al., 2009). 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 (Gutiérrez-Gutiérrez et al., 2016). 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 (Henderson et al., 2019; Cano et al., 2018; Gutiérrez-Gutiérrez et al., 2016).

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

(Feldman et al., 2009). It assess the severity of acute illness based on patient specific variables thus it has major advantages over other scores like APACHE and SOFA (Sojo-Dorado et al., 2022). 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 (Henderson et al., 2019) 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.

1.1 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

2. 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.

Sample Method and Sample Size: All patients under the inclusion criteria during the study period are included.

2.1 Inclusion Criteria

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

2.2 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

3. 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.

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

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.

4. 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

5. RESULTS

5.1 Study Population and 14-Day Inpatient Mortality

5.1.1 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.

5.2 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.

K. pneumoniae was isolated from 24 out of the 30 patients. From. The remaining 6 isolates were Enterobacter sp. (Cano et al., 2018), Escherichia coli (Paterson, 2004).

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.

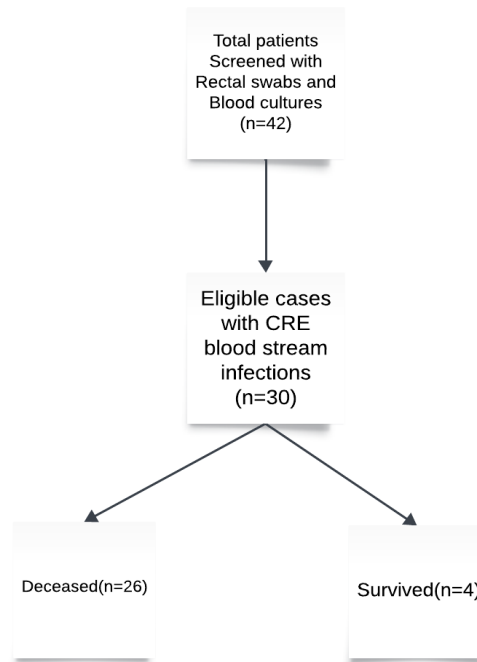


Fig. 1. Study protocol

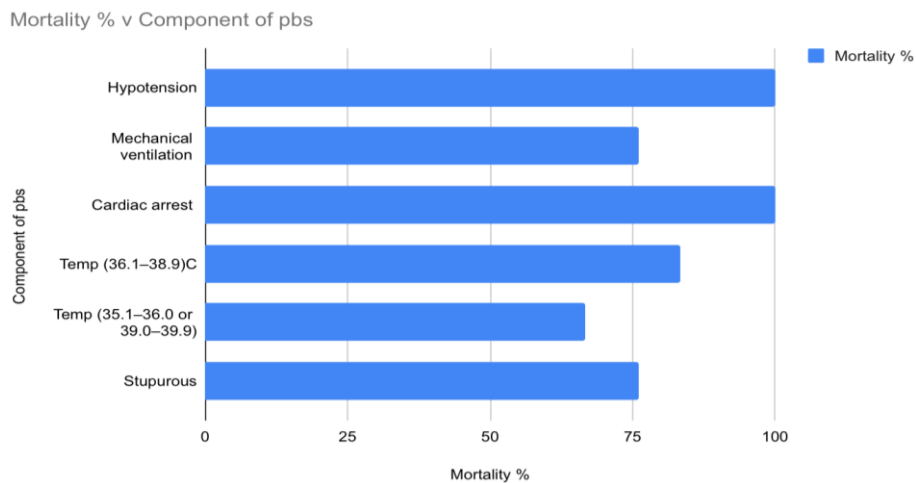


Fig. 2. Contribution of individual component of PBS In Mortality

Table 1. 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

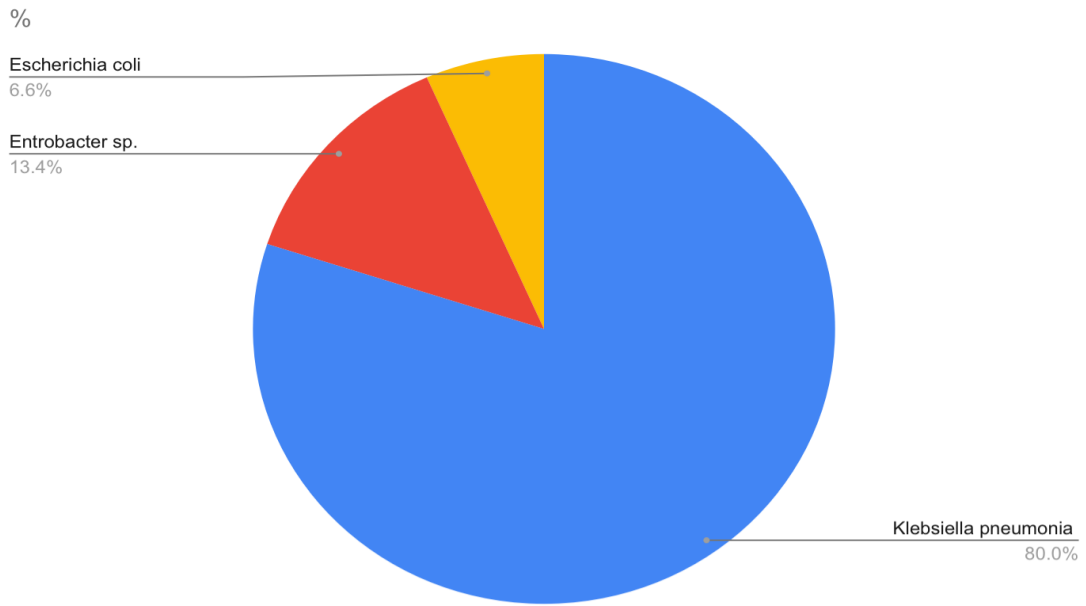
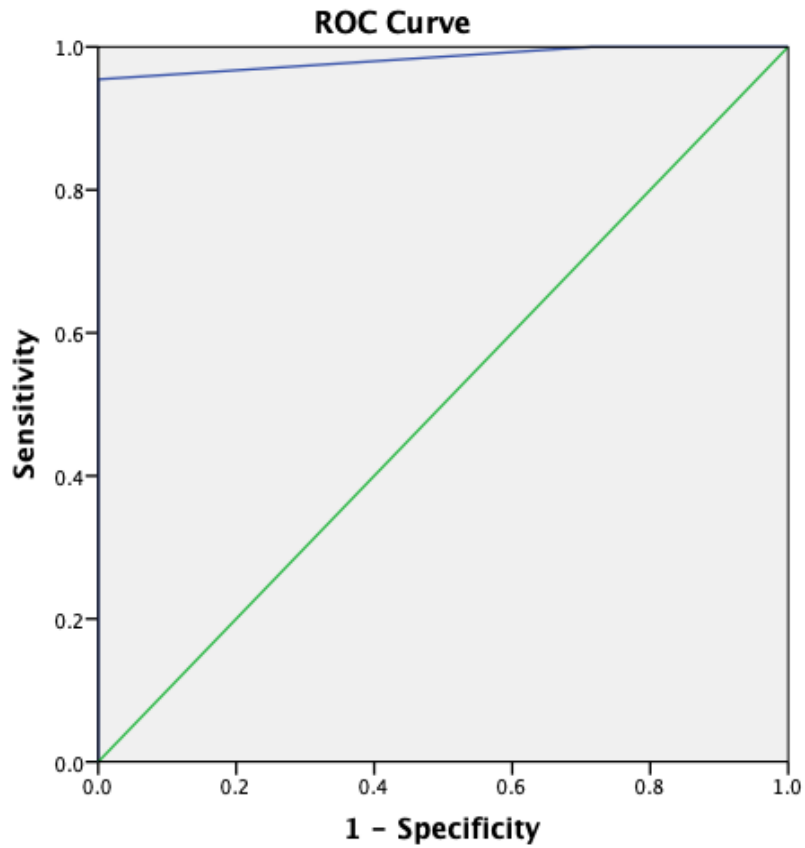


Fig. 3. Pie chart showing mortality percentage



Diagonal segments are produced by ties.

Fig. 4. Sensitivity vs specificity diagram

Table 2. 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 3. 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

5.2.1 Antimicrobial susceptibility testing results

List 2. Antibiotic sensitivity of the positive cultures (Resistant to meropenem) showed maximum resistance to Gentamicin 73% followed by Amikacin 53%

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

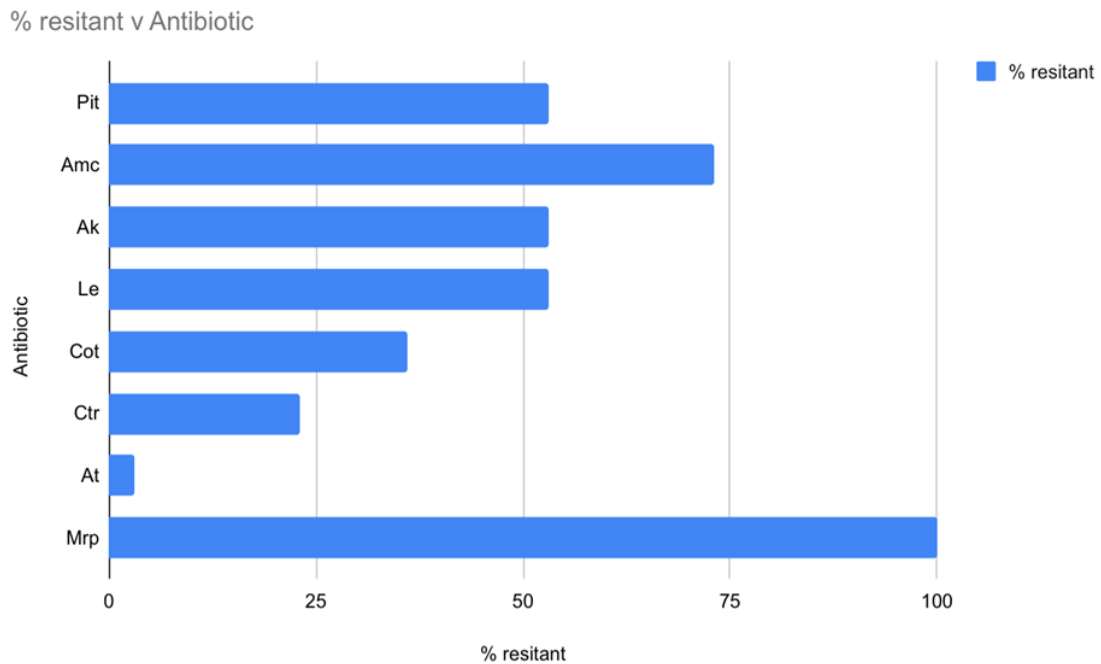


Fig. 5. Antimicrobial susceptibility testing results

6. 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 (Johnson et al., 2020).

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 (Chen et al., 2021).

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.

7. 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.

8. 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)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT

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

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Al-Hasan, M. N., Lahr, B. D., Eckel-Passow, J. E., & Baddour, L. M. (2013). Predictive scoring model of mortality in Gram-negative bloodstream infection. *Clinical Microbiology and Infection*, 19(10), 948–954.
- 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-Martínez, L., Rodríguez-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*, 66(8), 1204–1210. <https://doi.org/10.1093/cid/cix991>
- Chen, L., Han, X., Li, Y., & Li, M. (2021). Assessment of mortality-related risk factors and effective antimicrobial regimens for treatment of bloodstream infections caused by carbapenem-resistant *Enterobacterales*. *Antimicrobial Agents and Chemotherapy*, 65(9).
- 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 intensive care unit care. *Clinical Microbiology and Infection*, 15(9), 850–857. <https://doi.org/10.1111/j.1469-0691.2009.02901.x>
- 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., & the Carbapenem-Non-Susceptible Enterobacteriaceae in Europe Working Group. (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>
- 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>
- 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>
- Johnson, A. E., Pollard, T. J., Shen, L., et al. (2020). Multidrug-resistant organism infection score for predicting mortality in critically ill patients with gram-negative bacterial infection: A retrospective cohort study. *Annals of Intensive Care*, 10(1), 68. <https://doi.org/10.1186/s13613-020-00690-4>
- Nakada-Motokawa, N., Miyazaki, T., Ueda, T., Yamagishi, Y., Yamada, K., Kawamura, H., et al. (2021). Modified Pitt Bacteremia Score for predicting mortality in patients with candidemia: A multicenter seven-year retrospective study conducted in Japan. *Mycoses*, 64(12), 1498–1507. <https://doi.org/10.1111/myc.13337>
- 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>
- 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>
- Sojo-Dorado, J., López-Hernández, I., Rosso-Fernández, 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>
- Su, C., Tsai, I.-T., Lai, C. H., Lin, K. H., Chen, C., & Hsu, Y. C. (2023). Prediction of 30-day mortality using the quick Pitt

Bacteremia Score in hospitalized patients with *Klebsiella pneumoniae* infection. *Infection and Drug Resistance*, 16, 4807–4815.

Value of the Pitt Bacteremia Score to predict short-term mortality in *Staphylococcus aureus* bloodstream infection: A validation study. (2017). *Swiss Medical Weekly*, 147(31–32).

Vaquero-Herrero, M. P., Ragozzino, S., Castaño-Romero, F., Siller-Ruiz, M., Sánchez González, R., García-Sánchez, J. E., et al. (2017). 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*, 60(10), 676–685.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/127050>