OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE

Burns

Risk Models to Predict Mortality in Burn Patients: A Systematic Review and Meta-analysis

Mohamed Amir Mrad, MD, FRCSC, MBA, FACS*
Abdullah A. Al Qurashi, MBBS†‡
Qutaiba N. M. Shah Mardan, MBBS, MRCS(Eng)§
Faisal Ali Al Jabr, MBBS¶
Ahmed A. Almenhali, MBBS‖
Basma Bamakhrama, MBBS‖
Bayan Alsharif, MBBS**
Rakan Abdulkarim A. AlEtebi††
Abdullah Hatem Zarkan, MBBS†
Ibrahim A. Kattan, MBBS†
Nasser S. Alsubaie†
Amin Ghazi Gronfula, MBBS‡‡

Background: The predictive capability of various risk assessment models (RAMs) in evaluating the risk of mortality in burn patients is not well established. It is also unclear which RAM provides the highest discriminative ability and presents the highest clinical utility. We pooled all available studies to establish this validity and compare the predictive capability of the various RAMs.

Methods: We reviewed PubMed, MEDLINE, and Embase from their inception up until December 2021 for studies evaluating risk of mortality in burn patients as stratified by RAMs. Data were pooled using random-effect models and presented as area under the receiver operating characteristic (AUROC) curve.

Results: Thirty-four studies, comprising of a total of 98,610 patients, were included in our analysis. Most studies were found to have a low risk of bias and a good measure of applicability. Nine RAMs were evaluated. We discovered that the classic Baux; the revised Baux; and the Fatality by Longevity, APACHE II score, Measured Extent of burn, and Sex (FLAMES) scores presented with the highest discriminative power with there being no significant difference between the results presented by them [AUROCs (95% CI), 0.92 (0.90–0.95), 0.92 (0.90–0.93), 0.94 (0.91–0.97), respectively, with $P < 0.00001$ for all].

Conclusions: Many RAMs exist with no consensus on the optimal model to utilize and assess risk of mortality for burn patients. This study is the first systematic review and meta-analysis to compare the current RAMs' discriminative ability to predict mortality in patients with burn injuries. This meta-analysis demonstrated that RAMs designed for assessing mortality in individuals with burns have acceptable to great discriminative capacity, with the classic Baux, revised Baux, and FLAMES demonstrating superior discriminative performance in predicting death. FLAMES exhibited the highest discriminative ability among the RAMs studied. *(Plast Reconstr Surg Glob Open 2022;10:e4694; doi: 10.1097/GOX.0000000000004694; Published online 16 December 2022.)*

INTRODUCTION

Burn injuries have a substantial cost impact on health care and are responsible for an estimated 120,000 fatalities globally each year.[1] Even in well-equipped burn centers, fatality rates remain high (10%–20%).[2] The primary assessment method for measuring and evaluating the in-hospital care of individuals with burn-related injuries is patient mortality, and the risk of mortality is evaluated using prognostic risk assessment models (RAMs). The American Burn Association recommendations suggest risk criteria to assess the burns but lack a comprehensive overview of a distinct prognostic RAM due to a scarcity of investigations combining and assessing the models' prognostic accuracy.[3,4] Similarly, the European Burn Association guidelines for burn care lack any such discussion on RAMs and fail to recommend use of any particular RAM in assessing mortality in burn patients.[5]

Due to recent advances, over 40 models for burn assessment have been formulated. The Baux Index, which is the simplest and most frequently used, has

*From the *Plastic and Reconstructive Surgery Section, Department of Surgery, King Faisal Specialist Hospital & Research Centre, Riyadh, Saudi Arabia; †College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia; ‡King Abdullah International Medical Research Center, Jeddah, Saudi Arabia; §ABAS Medical Centre, Riyadh, Saudi Arabia; ¶King Faisal University, Al Ahsa, Saudi Arabia; ‖Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia; **General Surgery Department, Security Forces Hospital, Makkah, Saudi Arabia; ††Faculty of Medicine, Dar Al Uloom University, Riyadh, Saudi Arabia; and ‡‡School of Medicine, The Royal College of Surgeons in Ireland, Dublin, Ireland.*

Received for publication August 8, 2022; accepted October 6, 2022.

DOI: 10.1097/GOX.0000000000004694

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

been used to quantify the risk of mortality by calculating the sum of age and the total body surface area (TBSA) burned.[6] While the Baux Index is therapeutically efficacious and has a substantial permanence, it does not account for inhalation in burns, necessitating the development of the revised Baux Index.[7] Additionally, the Abbreviated Burn Severity Index (ABSI) was developed, but breakthroughs in intensive care and treatment have led to a decreasing trend in mortality due to severe burns, and studies have shown ABSI to be inadequate in predicting the likelihood of survival for severely burned individuals.[8–10] With recent advances, more novel and complex methods were developed such as Acute Physiology and Chronic Health Evaluation (APACHE) score II; Fatality by Longevity, APACHE II score, Measured Extent of burn, and Sex (FLAMES) score; Burns Evaluation and Mortality Study (BEAMS); and Prognostic Burns Index[11] but a comparison of these novel risk models has not been conducted. Some of the present models have been modified and reevaluated several times, and determining which model is more accurate and robust is uncertain.

An accurate model of burn mortality might be useful in reviewing treatment choices with patients and their families and formulating novel or creative approaches for individuals with burn injuries.[12] Because the previous validation studies vary in terms of patient demographics and procedural variables among the RAMs, pooled data from many validation studies may offer a more accurate evaluation of the RAM's performance than that from individual studies. The purpose of the present study was to examine systematically the effectiveness and discriminative performance of each RAM used for patients with burn injuries, by conducting a meta-analysis on pooled data from all studies evaluating burn RAM.

Takeaways

Question: Which risk model has the highest accuracy in predicting mortality in burn patients?

Findings: We discovered that the classic Baux, the revised Baux, and the FLAMES scores presented the highest discriminative power with there being no significant difference between the results presented by them.

Meaning: This meta-analysis demonstrates that risk stratification models designed for assessing mortality in burn victims demonstrate fair to excellent discriminative ability with classic Baux, revised Baux, and FLAMES showing excellent discriminative ability in predicting mortality.

METHODOLOGY

Data Sources and Search Strategy

This meta-analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[13] An electronic search of PubMed, MEDLINE, and Embase was conducted using the search strategy shown in Supplemental Digital Content 1. (**See appendix, Supplemental Digital Content 1,** which displays the supplementary material, **http://links.lww.com/PRSGO/C291**.) The search was conducted from the inception of the databases up until December 2021. We also manually screened the reference lists of the retrieved articles to identify any relevant studies.

Study Selection

The following criteria were used to select studies: studies evaluating discriminative power of mortality risk prediction in burn patients as measured by area under the receiver operating characteristic (AUROC) curve, with standard deviations, standard errors, or 95% confidence intervals (CIs).

Data Extraction

The articles retrieved from the systematic search were exported to EndNote Reference Library software through which duplicates were screened for and removed. The remaining articles were carefully assessed by two independent reviewers (A.A.Q. and F.A.J.), and only the studies that met the previously defined criteria were selected. All studies were inspected on the basis of title and abstract, after which the full text of the article was reviewed. A third investigator (A.M.) helped in resolving any discrepancies. The following data were abstracted for the purposes of this systematic review and meta-analysis: discrimination data (AUROC with 95% CIs) of the RAMs and pertinent calibration data [Hosmer–Lemeshow (H-L) statistics, study characteristics, sample size, study population, and geographical location].

Risk of bias (ROB) was evaluated via the Prediction Model Risk of Bias Assessment Tool.[14] This tool assesses the ROB and applicability of studies validating or deriving prognostic models using a series of 20 questions split into four major domains, namely participants, predictors, outcomes, and analysis.

Statistical Analysis

All analyses were conducted using RevMan (version 5.4.1; Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2020). The results from the included studies were presented as AUROCs with 95% CIs and were pooled using a random-effects model. Forest plots were created to evaluate the results of pooling. Higgins I^2 statistic was used to evaluate the heterogeneity of included studies.[15] A P value of less than 0.05 was considered statistically significant.

RESULTS

Literature Search Results

The initial search yielded 2097 potential studies. After exclusion, 34 trials remained for analysis. Nine RAMs were included in our analysis, namely the classic Baux, the revised Baux, the ABSI, the Ryan, the BOBI, the FLAMES, the APACHE II, the APACHE III, and the SOFA scores. The PRISMA flow chart summarizes the results of our literature search. (**See figure, Supplemental Digital Content 2,**

which displays the PRISMA flowchart, **http://links.lww.com/PRSGO/C292**; **see figure, Supplemental Digital Content 3,** which displays the discrimination of the classic Baux RAM, **http://links.lww.com/PRSGO/C293**; **see figure, Supplemental Digital Content 4,** which displays the discrimination of the revised Baux RAM, **http://links.lww.com/PRSGO/C294**; **see figure, Supplemental Digital Content 5,** which displays the discrimination of the FLAMES RAM, **http://links.lww.com/PRSGO/C295**.)

Study Characteristics and Quality Assessment

These trials evaluated a total of 98,610 patients. Eight of the 34 studies presented data on the classic Baux score; 22 of the 34 studies presented data on the revised Baux score; 16 the 34 studies presented data on the ABSI score; 10 of the 34 studies presented data on the Ryan score; 15 of the 34 studies presented data on the BOBI score; five of the 34 studies presented data on the FLAMES score; seven of the 34 studies presented data on the APACHE II score; three of the 34 studies presented data on the APACHE III score; and five of the 34 studies presented data on the SOFA score. Baseline characteristics of all trials are presented in **Table S3, Supplemental Digital Content 1, http://links.lww.com/PRSGO/C291**. ROB assessment using the Prediction Model Risk of Bias Assessment Tool demonstrated that most included studies demonstrated a low risk of bias and a high degree of applicability and can be considered, as such, to be of high methodological quality. (**See Table S2, Supplemental Digital Content 1, http://links.lww.com/PRSGO/C291**.)

Results of Meta-analysis

Overall, our results demonstrated that the classic Baux (AUCs, 0.92; CIs, 0.90-0.95), revised Baux (AUCs, 0.92, CIs, 0.90-0.93), and FLAMES score (AUCs, 0.94, CIs, 0.91-0.97) presented the best discrimination to evaluate mortality in burn patients, with no significant difference between them. The results of the meta-analysis are summarized in Table 1.

DISCUSSION

This meta-analysis of 98,610 patients demonstrated that RAMs designed for assessing mortality in burn patients demonstrate fair to excellent discriminative ability (range, 0.79–0.94); however, classic Baux (C-statistic = 0.92), revised Baux (C-statistic = 0.92), and FLAMES (C-statistic = 0.94) RAMs have shown excellent discriminative ability in predicting mortality, FLAMES having the highest discriminative ability among the RAMs evaluated.

Our study found that the classic Baux score and revised Baux score have excellent discriminative abilities to predict mortality in burn patients. As early as the 1930s, age and the percentage of TBSA burned were recognized as the major prognostic markers in patients with burn injuries.[16] The classic Baux score, formulated in 1961,[17] is evaluated by the sum of age of the individual and the percentage of TBSA burned. An extra year or an extra percent of body surface area burned would raise the projected percent fatality by the same amount. To put it another way, the score was designed to demonstrate that a 50-year-old individual with a 50% burn-affected area was nearly guaranteed to die. Although classic Baux score has been shown to have a significant prognostic ability,[18] it failed to incorporate the factor of inhalation in burn injuries, which has now been identified as a significant cause of death after burn injuries.[7] With the modern advances in the development of topical antibiotics, prompt excision and grafting, and a slew of other advancements in intensive care have enhanced survivability to the point that the classic Baux scores' projections are now unreasonably negative.[8] To formulate a revised Baux score, Osler et al[7] found it plausible to inquire if the classic Baux score might be amended to include inhalation damage, and it was reevaluated in light of contemporary burn treatment practices without jeopardizing its inherent flexibility, hence, resulting in a revised Baux score, for which some researchers have shown a higher degree of predictability as compared with the classic Baux score,[18] although our results have shown a similar discriminative ability of classic Baux and revised Baux score. A considerable critique of these scoring systems is that they fail to examine the existence of comorbidities that could influence the scores' prognostic result.

Our findings show that the FLAMES score outperformed the classic or revised Baux in terms of discriminative ability to predict the risk of mortality in patients with burn injuries. Hassan et al[19] conducted research to investigate FLAMES, BOBI, and revised Baux scores, and they concluded that the FLAMES score had a greater predictive potential, with a sensitivity of 96% and the higher specificity of 99%, as compared with revised Baux with a sensitivity and specificity of 96% and 90%. Robust and comprehensive, the FLAMES score was developed by Gomez et al[20] in 2008, and it incorporates parameters such as a burn patient's APACHE II score, gender, age, and the depth of burn. When it comes to predicting patient mortality among the critically ill patients, the APACHE II score is considered a gold standard,[21] but the comprehensive patient data necessary to generate the score, which

Table 1. Summary of the Results of the Meta-analysis

Score Name	AUC (95% Cls)	*P*	Heterogeneity (%)
Classic Baux	0.92 (0.90–0.95)	<0.00001	88
Revised Baux	0.92 (0.90–0.93)	<0.00001	91
ABSI	0.89 (0.86–0.91)	<0.00001	86
Ryan	0.85 (0.82–0.87)	<0.00001	74
BOBI	0.87 (0.85–0.90)	<0.00001	80
FLAMES	0.94 (0.91–0.97)	<0.00001	78
APACHE II	0.81 (0.73–0.88)	<0.00001	86
APACHE III	0.87 (0.84–0.90)	<0.00001	1
SOFA	0.79 (0.65–0.94)	<0.00001	91

includes hemodynamic condition, ventilation status, and laboratory investigations, are a potential downside of the scoring method.[22] Since the APACHE II score is used to evaluate critically ill patients and the researchers who formulated this score excluded burn patients during their study,[21] APACHE II is incorporated into the FLAMES score, which is a much more modified score system than APACHE II.[20] Despite the fact that FLAMES score demonstrated high prognostic ability in our analysis, it is not particularly practical due to the fact that it distinguishes between partial and full-thickness burns. Even skilled burn surgeons may struggle with this judgment as depth of the burn may not be evident on the very first physical examination of the patient; hence, the FLAMES score may not be preferred by certain clinicians as a practical and usable tool in regular practice.[19,23]

Our findings show that ABSI and BOBI scores have good discriminative ability, although ABSI has demonstrated a higher discriminative ability in our analysis. BOBI scores comprise of 10-point score system, where age, TBSA burned, and inhalation injury determine the score of the patient with burn injuries, and a score of 10 points would predict a 99% risk of fatality in the burn injuries.[24,25] On the other hand, the ABSI scores incorporate the gender and presence of any complete thickness burns on the patient along with inhalation injury, age, and percentage of body surface burned.[26] Studies comparing ABSI and BOBI scores demonstrate that ABSI has a higher sensitivity (81.6% versus 73.1% BOBI) and a higher specificity (92.5% versus 91.8% BOBI).[12] However, these models have a critical flaw, which is that they fail to account for comorbidities in burn patients, and fail to consider mortality in older and/or critical care patients.[27] Taylor et al[28] concluded that predicting mortality using "one size fits all" methods fails to take into account the unique needs of older and pediatric patients with burn injuries, and hence, age-specific scoring systems for prognosticating mortality should be established. Additionally, because of the natural decline in immune function and the flattening of skin that occurs as people age,[29] it is imperative that new age-specific risk scores be devised. Thin skin and weak immunity may lead to a lengthier healing interval to recover for older burn patients. Older people are more likely to die from burns because they have more preexisting health conditions, a weaker immune capacity to fight off postburn infections, and thinner skin that leads to more severe burns.[30]

Among the other scores included in our study, the Ryan score, SOFA score, and APACHE III score, the APACHE III score had the highest discriminative ability to predict mortality, whereas the SOFA score had the lowest ability to predict mortality in burn patients, among all the included scores in the study. The SOFA score is used to evaluate organ failure caused by acute infection in organ systems, and was first designed for patients with sepsis.[31] The APACHE III score included in our study had a higher discriminative ability in predicting mortality than APACHE II, which has been shown by other studies as well.[32] The APACHE II and APACHE III scores are used in critically ill patients, but the APACHE III includes more variables for evaluation and hence, is more time-consuming.[33] Although there is a lack of studies evaluating APACHE III score in burn patients, a study done by Kuo et al[34] concluded that sensitivity of the APACHE III score is higher than APACHE II, whereas the specificity is lower (sensitivity: 76% versus 62%; specificity: 84% versus 86%). However, if we compare the APACHE III with SOFA score, the SOFA score has a lower sensitivity (76%) and specificity (66%).[34]

Implementing prognostic scores to assess the likelihood of mortality in burn patients is an effective way for identifying the proportion of participants who require further attention in terms of therapy, resource conservation, and cost containment.[18] Our study is the first systematic review and meta-analysis to pool the validation studies and compare the current RAMs' discriminative ability to prognosticate mortality in patients with burn injuries. Our findings will facilitate the development of improved guidelines and recommendations for patients with burn injuries, since our findings corroborate and increase existing information about RAMs. Additionally, our results aid future investigators by paving the road for them to investigate specific RAMs with high discriminative power, as well as identifying models that have not been investigated before.

To interpret our findings, we must consider a number of limitations in our study. First, even though our analysis included the most commonly used RAMs, some of the other scores that are used for prognosticating mortality in burn patients were not included in our study. These were McGwin's score,[35] Simplified Acute Physiology Score,[36] American Society of Anesthesiologists Physical Status Score,[37] Burns Evaluation and Mortality Study,[38] and Prognostic Burn Index.[39] Second, in those studies where data were not extracted or those RAMs which were not included, it was because either they did not have a significant number of validation studies conducted to assess their prognostic ability or the few studies that were published failed to report variables that were required to assess the discrimination of an RAM. Third, there was a significant heterogeneity among the studies that were included to evaluate the RAMs. In the future, more studies with large prospective validation cohorts and less homogenous cohorts are required to better assess the discriminative ability of the RAMs. New scores need to be designed to prognosticate the risk of mortality among the pediatric and older burn patients, and validation studies should be conducted for them. Fourth, available pediatric models such as pediatric Baux were not included in this analysis due to paucity of studies. Finally, we only looked at mortality, excluding validated models that may predict the likelihood of a patient being hospitalized.

In conclusion, our study demonstrates that RAMs such as the classic Baux, revised Baux, and FLAMES scores have excellent discriminative ability as they include different parameters, such as age, gender, TBSA burned, and depth of burn, which play a key role in predicting the risk of mortality in these patients. However, there are a few drawbacks in using these scores in patients with burn injuries. More studies are necessary to create scores for older and pediatric

patients and to better comprehend the effectiveness of certain other scores, which are not included in this study.

Mohamed Amir Mrad, MD, FRCSC, MBA, FACS
Plastic and Reconstructive Surgery Section
Department of Surgery
King Faisal Specialist Hospital & Research Centre
P.O. Box 3354
Riyadh 11211, Saudi Arabia
E-mail: amirmurad@gmail.com

REFERENCES

1. James SL, Lucchesi LR, Bisignano C, et al. Epidemiology of injuries from fire, heat and hot substances: global, regional and national morbidity and mortality estimates from the global burden of disease 2017 study. *Inj Prev.* 2020;26(suppl 2):i3i36–i3i11.
2. Seo DK, Kym D, Yim H, et al. Epidemiological trends and risk factors in major burns patients in South Korea: a 10-year experience. *Burns.* 2015;41:181–187.
3. Pham TN, Cancio LC, Gibran NS. American Burn Association practice guidelines burn shock resuscitation. *J Burn Care Res.* 2008;29:257–266.
4. American Burn Association Practice Guidelines Committee. Practice guidelines for burn care: initial assessment of the burn patient. *J Burn Care Rehabil Suppl, Chapter 2.* 2001:5S–9S.
5. Beerthuizen G, Magnette A. *European Practice Guidelines for Burn Care. Minimum Level of Burn Care Provision in Europe.* Barcelona: European Burns Association; 2017.
6. Hussain A, Choukairi F, Dunn K. Predicting survival in thermal injury: a systematic review of methodology of composite prediction models. *Burns.* 2013;39:835–850.
7. Osler T, Glance LG, Hosmer DW. Simplified estimates of the probability of death after burn injuries: extending and updating the Baux score. *J Trauma Acute Care Surg.* 2010;68:690–697.
8. Liu HF, Zhang F, Lineaweaver WC. History and advancement of burn treatments. *Ann Plast Sur.* 2017;78:S2–S8.
9. Zuo KJ, Medina A, Tredget EE. Important developments in burn care. *Plast Reconstr Surg.* 2017;139:120e–138e.
10. Bartels P, Thamm OC, Elrod J, et al. The ABSI is dead, long live the ABSI-reliable prediction of survival in burns with a modified abbreviated burn severity index. *Burns.* 2020;46:1272–1279.
11. Dahal P, Ghimire S, Maharjan NK, et al. Baux's and abbreviated burn severity score for the prediction of mortality in patients with acute burn injury. *J Coll Med Sci-Nepal.* 2015;11:24–27.
12. Herlianita R, Purwanto E, Wahyuningsih I, et al. Clinical outcome and comparison of burn injury scoring systems in burn patient in Indonesia. *Afr J Emergency Med.* 2021;11:331–334.
13. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71.
14. Wolff RF, Moons KG, Riley RD, et al. PROBAST: a tool to assess the risk of bias and applicability of prediction model studies. *Ann Intern Med.* 2019;170:51–58.
15. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ.* 2003;327:557–560.
16. Lutken P. Mortality from burns. *Ugesk Laeger.* 1937;99:409.
17. Kibadi K, Moutet F. Traitement des séquelles de brûlures de la main dans les pays à ressources limitées ; notre expérience en république démocratique du Congo. *Ann Burns Fire Disasters.* 2015;28:32-38 [In French].
18. Lam NN, Hung NT, Duc NM. Prognosis value of revised Baux score among burn patients in developing country. *Int J Burns Trauma.* 2021;11:197–201.
19. Hassan Z, Burhamah W, Alabdulmuhsen S, et al. The analysis and accuracy of mortality prediction scores in burn patients admitted to the intensive care burn unit (ICBU). *Ann Med Surg.* 2021;65:102249.
20. Gomez M, Wong DT, Stewart TE, et al. The FLAMES score accurately predicts mortality risk in burn patients. *J Trauma Acute Care Surg.* 2008;65:636–645.
21. Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification system. *Crit Care Med.* 1985;13:818–829.
22. Halgas B, Bay C, Foster K. A comparison of injury scoring systems in predicting burn mortality. *Ann Burns Fire Disasters.* 2018;31:89–93.
23. Monstrey S, Hoeksema H, Verbelen J, et al. Assessment of burn depth and burn wound healing potential. *Burns.* 2008;34:761–769.
24. Blot S. Development and validation of a model for prediction of mortality in patients with acute burn injury: the Belgian outcome in burn injury study group. *Br J Surg.* 2008;96:111–117.
25. Smith DL, Cairns BA, Ramadan F, et al. Effect of inhalation injury, burn size, and age on mortality: a study of 1447 consecutive burn patients. *J Trauma.* 1994;37:655–659.
26. Tobiasen J, Hiebert JM, Edlich RF. The abbreviated burn severity index. *Ann Emergency Med.* 1982;11:260–262.
27. Masud D, Norton S, Smailes S, et al. The use of a frailty scoring system for burns in the elderly. *Burns.* 2013;39:30–36.
28. Taylor SL, Lawless M, Curri T, et al. Predicting mortality from burns: the need for age-group specific models. *Burns.* 2014;40:1106–1115.
29. Lionelli GT, Pickus EJ, Beckum OK, et al. A three decade analysis of factors affecting burn mortality in the elderly. *Burns.* 2005;31:958–963.
30. Jeschke MG, Pinto R, Costford SR, et al. Threshold age and burn size associated with poor outcomes in the elderly after burn injury. *Burns.* 2016;42:276–281.
31. Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. *Intensive Care Med.* 1996;22:707–710.
32. Hsu CW, Wann SR, Chiang HT, et al. Comparison of the APACHE II and APACHE III scoring systems in patients with respiratory failure in a medical intensive care unit. *J Formos Med Assoc.* 2001;100:437–442.
33. Sadaka F, EthmaneAbouElMaali C, Cytron MA, et al. Predicting mortality of patients with sepsis: a comparison of APACHE II and APACHE III scoring systems. *J Clin Med Res.* 2017;9:907.
34. Kuo G, Yang SY, Chuang SS, et al. Using acute kidney injury severity and scoring systems to predict outcome in patients with burn injury. *J Formos Med Assoc.* 2016;115:1046–1052.
35. McGwin G Jr, George RL, Cross JM, et al. Improving the ability to predict mortality among burn patients. *Burns.* 2008;34:320–327.
36. Pantet O, Faouzi M, Brusselaers N, et al. Comparison of mortality prediction models and validation of SAPS II in critically ill burns patients. *Ann Burns Fire Disasters.* 2016;29:123.
37. Choi KJ, Pham CH, Collier ZJ, et al. The predictive capacity of American Society of Anesthesiologists Physical Status (ASA PS) score in burn patients. *J Burn Care Res.* 2020;41:803–808.
38. Moore EC, Pilcher DV, Bailey MJ, et al. The burns evaluation and mortality study (BEAMS): predicting deaths in Australian and New Zealand burn patients admitted to intensive care with burns. *J Trauma Acute Care Surg.* 2013;75:298–303.
39. Yoshimura Y, Saitoh D, Yamada K, et al. Comparison of prognostic models for burn patients: a retrospective nationwide registry study. *Burns.* 2020;46:1746–1755.