A nomogram to predict in-hospital mortality of neonates admitted to the intensive care unit

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Background: To explore the influencing factors for in-hospital mortality in the neonatal intensive care unit (NICU) and to establish a predictive nomogram.

Methods: Neonatal data were extracted from the Medical Information Mart for Intensive Care III (MIMIC-III) database. Both univariate and multivariate logit binomial general linear models were used to analyse the factors influencing neonatal death. The area under the receiver operating characteristics (ROC) curve was used to assess the predictive model, which was visualized by a nomogram.

Results: A total of 1258 neonates from the NICU in the MIMIC-III database were eligible for the study, including 1194 surviving patients and 64 deaths. Multivariate analysis showed that red cell distribution width (RDW) (odds ratio [OR] 0.813, p = 0.003) and total bilirubin (TBIL; OR 0.644, p < 0.001) had protective effects on neonatal in-hospital death, while lymphocytes (OR 1.205, p = 0.025), arterial partial pressure of carbon dioxide (PaCO2; OR 1.294, p = 0.016) and sequential organ failure assessment (SOFA) score (OR 1.483, p < 0.001) were its independent risk factors. Based on this, the area under the curve of this predictive model was up to 0.865 (95% confidence interval 0.813 to 0.917), which was also confirmed by a nomogram.

Conclusions: The nomogram constructed suggests that RDW, TBIL, lymphocytes, PaCO2 and SOFA score are all significant predictors for in-hospital mortality in the NICU.

Keywords: in-hospital mortality, MIMIC database, neonates, nomogram.

Introduction

Despite a significant decrease in global childhood mortality, neonatal mortality remains relatively high, accounting for approximately 40% of all childhood mortality. Each year 2.6 million neonates die globally, with 75% of neonatal deaths occurring in the first week of life and 99% die in low- and middle-income countries (LMICs). Due to the lack of a surveillance system in developing countries, neonatal sepsis in LMICs is likely underreported, indicating the proportion of neonatal mortality may be even higher. Neonatal mortality is becoming a prominent component of the overall mortality of children <5 y of age. Prematurity, intrapartum-related complications like birth asphyxia and neonatal sepsis are thought to be the three leading causes of neonatal mortality.

Currently neonatal deaths can be decreased via extra care for preterm newborns, provision of feeding support, improvement of resuscitation skills and infection prevention. Recent global estimates indicate that increasing the coverage of existing interventions can prevent about 75% of newborn deaths. Although these solutions are achievable, neonatal mortality is still a big challenge for LMICs, especially in southern Asia and sub-Saharan Africa. Identifying the risk factors is beneficial to predict the mortality of neonates, especially where intervention is feasible with modest resources. Houweling et al. found that preterm birth, multiple births and poor condition at 5 min post-partum were associated with a significantly increased risk of neonatal mortality and thus they established prediction models for neonatal death. However, these prediction models are appropriate for assessing neonatal mortality in the general population of South Asia. The current study explores the influencing factors for neonatal mortality in the neonate intensive care unit (NICU) using the Medical Information Mart for Intensive Care III (MIMIC-III) database and to construct a nomogram for predicting neonatal mortality, aimed at providing more evidence for the prevention and treatment of neonatal mortality in the NICU.
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15. Data from the MIMIC-III database was used to extract data. The MIMIC-III database was used to extract data. The MIMIC-III, an openly available dataset, the study did not get approval for diagnosis of lung injury and TBIL reflects liver metabolism. 17, 18

Methods

Patients

The MIMIC-III database was used to extract data. The MIMIC-III is a large, free database that contains de-identified health data for >40,000 ICU patients from the Beth Israel Deaconess Medical Center (Boston, MA, USA) between 2001 and 2012. 13 It not only contains demographics, vital signs, medications and laboratory tests, but also includes observations and notes charted by care providers, procedures and diagnostic codes, fluid balance, imaging reports, length of stay and survival data. According to the MIMIC-III, 7874 neonates were admitted to the NICU. 14 Neonates with a gestational age of 23–31 weeks were included in our study, while those with missing data, including birthweight, vital signs and laboratory measurements, were excluded.

Since the data used in this study were accessed from MIMIC-III, an openly available dataset, the study did not get approval from the Institutional Review Board of Guangdong Second Provincial General Hospital.

Data collection

Data from the MIMIC-III used for analysis in this study included gender, birthweight, heart rate, laboratory parameters (bicarbonate, haematocrit, haemoglobin, white blood cell [WBC] count, red blood cell [RBC] count, platelet [PLT] count, red cell distribution width [RDW], neutrophils, lymphocytes, sodium, total bilirubin [TBIL], fraction of inspired oxygen [FiO2], arterial partial pressure of carbon dioxide [PaCO2], arterial partial pressure of oxygen [PaO2]), sequential organ failure assessment (SOFA) score and the Simplified Acute Physiology Score II (SAPS II). These data could be downloaded from several sources, including archives from critical care information systems, hospital electronic health record databases and Social Security Administration Death Master File. 14

Neonatal deaths in this study were defined as death occurring within 30 d following admission to the NICU. The SOFA score was developed to assess the acute morbidity of critical illness at the patient level based on six criteria—cardiovascular, respiratory, nervous, hepatic, renal and haematological systems—each scored on a scale of 0–4. The higher the SOFA score, the worse the organ dysfunction. 15 The SAPS II provides an estimate of the risk of death without specifying a primary diagnosis. It contains 17 variables: age, type of admission, 12 physiology variables and 3 underlying disease variables. 16 PaO2 and FiO2 are commonly used for diagnosis of lung injury and TBIL reflects liver metabolism. 17, 18

Statistical analysis

Categorical data were presented as number and percentage, while the $\chi^2$ test or Fisher’s exact test was used for compar-

| Variables | Survival group (n=1194) | Death group (n=64) | Total (N=1258) | Statistic | p-Value |
|-----------|------------------------|-------------------|----------------|-----------|---------|
| Gestational age (weeks) | 27.89±1.95 | 27.78±1.70 | 27.89±1.94 | t=0.44 | 0.660 |
| Gender, n (%) | Male 695 (58.21) Female 499 (41.79) | 38 (59.38) 26 (40.62) | 733 (58.27) 525 (41.73) | $\chi^2=0.03$ | 0.854 |
| Birthweight (kg) | 1.60 (1.13–2.40) | 0.92 (0.68–1.50) | 1.58 (1.11–2.36) | Z=-6.061 | <0.001 |
| Heart rate (bpm) | 156 (144–166) | 154 (144–165) | 156 (144–166) | Z=0.783 | 0.434 |
| Laboratory parameters | Bicarbonate (mmol/L) 21.00 (19.00–23.00) | 20.70 (19.00–22.00) | 21.00 (19.00–23.00) | Z=-1.943 | 0.052 |
| Haematocrit (%) 46.60 (41.70–50.90) | 43.22 (40.05–47.05) | 46.25 (41.60–50.80) | Z=-3.201 | 0.001 |
| Haemoglobin (g/dl) 15.50 (13.90–17.00) | 14.66 (13.50–15.60) | 15.50 (13.80–17.00) | Z=-3.096 | 0.002 |
| WBC count ($\times10^9$/μL) 10.20 (6.90–14.50) | 8.80 (5.00–11.55) | 10.20 (6.90–14.50) | Z=-2.171 | 0.030 |
| RBC count ($\times10^9$/μL) 4.16 (3.74–4.61) | 3.83 (3.47–4.22) | 4.14 (3.73–4.59) | Z=-4.319 | <0.001 |
| PLT count ($\times10^9$/μL) 251.00 (198.00–311.75) | 214.50 (174.00–240.75) | 248.00 (197.00–309.00) | Z=-3.705 | <0.001 |
| RDW (%) 17.00 (16.30–17.80) | 16.80 (15.75–17.26) | 17.00 (16.30–17.70) | Z=2.892 | 0.004 |
| Neutrophils (%) 29.00 (18.00–44.00) | 23.50 (17.75–35.00) | 29.00 (18.00–44.00) | Z=2.178 | 0.029 |
| Lymphocytes (%) 57.00 (40.00–70.00) | 62.00 (49.75–72.50) | 57.00 (41.00–70.00) | Z=-2.220 | 0.026 |
| Sodium (mEq/L) 139.00 (136.00–141.00) | 139.68 (138.00–144.50) | 139.00 (136.00–141.00) | Z=2.649 | 0.008 |
| TBIL (mg/dL) 5.10 (4.00–6.20) | 2.90 (2.25–3.10) | 5.10 (3.90–6.20) | Z=7.782 | <0.001 |
| FiO2 30.00 (23.25–50.00) | 40.00 (30.00–70.00) | 30.00 (24.00–50.00) | Z=3.805 | <0.001 |
| PaCO2 (mmHg) 47.00 (39.00–60.75) | 47.00 (39.00–60.75) | 47.00 (39.00–60.75) | Z=1.309 | 0.191 |
| PaO2 (mmHg) 50.00 (41.00–71.00) | 50.00 (41.00–71.00) | 50.00 (41.00–71.00) | Z=1.816 | 0.069 |
| Scoring systems | SOFA score 6.00 (4.00–7.00) | 8.00 (6.00–9.00) | 6.00 (4.00–7.00) | Z=5.593 | <0.001 |
| SAPS II 34 (30–39) | 37 (33–41) | 34 (30–39) | Z=2.376 | 0.018 |

Values are presented as median (IQR; quartile 1–quartile 3) unless stated otherwise.
## Results

### Baseline characteristics of included neonates

Of 7874 neonates admitted to the NICU, there were 7800 with a gestational age of 23–31 weeks. After excluding 6542 patients with missing data (birthweight 621 patients, survival outcomes 1345 patients, laboratory parameters 3992 patients and scoring systems 584 patients), 1258 neonates (733 males [58.27%] and 525 females [41.73%]) were eligible for the study. In-hospital death occurred in 64 patients. All included subjects were included in the death group (n = 64) and 1194 were included in the survival group. The baseline characteristics of the two groups are compared in Table 1. It can be observed that except for gender, heart rate, PaCO2, PaO2 and bicarbonate, the differences were all pronounced between the death group and the survival group regarding other variables, including birthweight (p < 0.001), WBC count (p = 0.030), RBC count (p < 0.001), PLT count (p < 0.001), haematocrit (p = 0.001), haemoglobin (p = 0.002), RDW (p = 0.004), neutrophils (p = 0.029), lymphocytes (p = 0.026), TBIL (p < 0.001), FiO2 (p < 0.001), sodium (p = 0.008), SOFA score (p < 0.001) and SAPS II (p < 0.018).

### Univariate and multivariate analysis of in-hospital death in neonates

Univariate and multivariate analysis of in-hospital death in neonates is presented in Table 2. As it shows, birthweight (odds ratio [OR] 0.335, p < 0.001), RBC count (OR 0.459, p < 0.001), PLT count (OR 0.995, p = 0.001), haematocrit (OR 0.957, p = 0.006), haemoglobin (OR 0.880, p = 0.007), RDW (OR 0.845, p = 0.037), neutrophils (OR 0.982, p = 0.023), TBIL (OR 0.524, p < 0.001) and bicarbonate (OR 0.892, p = 0.003) were all associated with a reduced risk of in-hospital death in neonates, whereas lymphocytes (OR 1.180, p = 0.024), FiO2 (OR 1.011, p = 0.004), PaCO2 (OR 1.262, 

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### Table 2. Factors associated with in-hospital death among neonates

| Variables               | Univariate analysis | Multivariate analysis |
|-------------------------|---------------------|-----------------------|
|                         | OR (95% CI)         | p-Value               | OR (95% CI)         | p-Value               |
| Gestational age (weeks) | 0.971 (0.853 to 1.014) | 0.649                | 0.968 (0.888 to 1.056) | 0.464                |
| Gender (female)         | 1.049 (0.629 to 1.751) | 0.854                |                       |                      |
| Birthweight (kg)        | 0.335 (0.216 to 0.518) | <0.001               |                       |                      |
| Heart rate (bpm)        | 0.986 (0.972 to 1.001) | 0.059                |                       |                      |
| Laboratory parameters   |                     |                       |                       |                      |
| WBC count (×10^9/L)     | 0.957 (0.914 to 1.001) | 0.057                |                       |                      |
| RBC count (×10^6/μL)    | 0.495 (0.352 to 0.696) | <0.001               |                       |                      |
| PLT count (×10^9/L)     | 0.995 (0.993 to 0.998) | 0.001                |                       |                      |
| Haematocrit (%)         | 0.957 (0.928 to 0.987) | 0.006                |                       |                      |
| Haemoglobin (g/dL)      | 0.880 (0.801 to 0.966) | 0.007                |                       |                      |
| RDW (%)                 | 0.845 (0.723 to 0.990) | 0.037                | 0.813 (0.710 to 0.932) | 0.003                |
| Neutrophils (%)         | 0.982 (0.967 to 0.998) | 0.023                |                       |                      |
| Lymphocytes (%)         | 1.180 (1.022 to 1.361) | 0.024                | 1.205 (1.024 to 1.417) | 0.025                |
| TBIL (mg/dL)            | 0.524 (0.439 to 0.624) | <0.001               | 0.644 (0.529 to 0.785) | <0.001               |
| FiO2                    | 1.011 (1.004 to 1.020) | 0.004                |                       |                      |
| PaCO2 (mmHg)            | 1.262 (1.012 to 1.574) | 0.039                | 1.294 (1.049 to 1.596) | 0.016                |
| PaO2 (mmHg)             | 1.000 (0.994 to 1.006) | 0.907                |                       |                      |
| Sodium (mEq/L)          | 1.089 (1.035 to 1.145) | <0.001               |                       |                      |
| Bicarbonate (mEq/L)     | 0.892 (0.827 to 0.963) | 0.003                |                       |                      |
| SOFA score              | 1.533 (1.400 to 1.678) | <0.001               | 1.483 (1.334 to 1.649) | <0.001               |

Continuous variables were expressed as medians and interquartile ranges (IQRs). Differences in baseline information of included neonates and clinical characteristics, as well as laboratory parameters between groups, were compared according to univariate and multivariate analysis.
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Figure 1. The nomogram for predicting 30-d in-hospital mortality in the NICU.

Figure 2. The ROC curve for the predictive model.

Nomogram for predicting in-hospital mortality in the NICU

A nomogram was constructed using the determinants identified in multivariate analysis of in-hospital mortality (Figure 1). The score for each parameter was obtained through upward projection of each variable to the value of the small ruler (points). Adding the points assigned to the corresponding factors determined the total points. The higher the total score, the higher the risk of mortality. For each patient, the risk of in-hospital mortality could be individually predicted by the nomogram. The predictive accuracy of this model was then assessed and the AUC of the nomogram was 0.865 (95% CI 0.813 to 0.917) (Figure 2). The data from one patient in the training set were randomly extracted for validation. If the gestational age of the baby was 28 weeks, the total score would be 383 by adding the variables (PaCO2 7 mmHg, RDW 17.19%, lymphocytes 47%, SOFA score 9, TBIL 3.1 mg/dL), with a risk of death of 0.517. This case was alive, highlighting the predictive accuracy (Figure 3).
Discussion

Considering the high neonatal mortality rates, neonatal health is still a matter of great concern around the world. In this study, we used data from 1258 NICU neonates in the MIMIC-III database, including 1194 surviving patients and 64 deaths. Our results indicated that RDW and TBIL had protective effects on neonatal in-hospital death, while lymphocytes, PaCO₂ and SOFA score were independent risk factors for neonatal in-hospital mortality. Using our findings, we constructed a nomogram that was easy to use in the prediction of in-hospital mortality in the NICU. The model, with its high accuracy, is helpful for the optimization of clinical management.

RDW, a standard parameter of the complete blood count, represents variability in RBC size. Its increase reflects greater variability in RBC size, usually suggesting dysfunctional erythropoiesis, premature release of reticulocytes or shortened RBC lifespan. RDW can not only help diagnose iron deficiency anaemia, but can also predict outcomes of various comorbidities in children and adults. Studies on the association of RDW with neonatal sepsis have shown that RDW is an independent outcome predictor for mortality related to neonatal sepsis, highlighting the prognostic value of RDW in neonatal sepsis, the third leading cause of neonatal deaths. In our study, RDW was also identified as a significant protective factor for in-hospital mortality in the NICU, which was supported by the study of Said et al. This finding increased awareness of the association between RDW and the risk of neonatal mortality.

TBIL is a crucial diagnostic marker. Our results showed the protective role of TBIL in NICU neonates, as the risk of death in neonates increase 0.644-fold at each 1 mg/dL addition. A study presented by Dani et al. found a lower TBIL level in infants with moderate to severe hypoxic–ischaemic encephalopathy (HIE) than in those without HIE. They speculated that the increased TBIL was not a neuroprotective mechanism in infants with HIE. The correlation between TBIL levels and oxidative stress among newborns has been investigated and it was found that low physiologic TBIL levels are relevant to antioxidant effects, whereas high pathologic TBIL levels are correlated with prooxidant effects. In contrast, Song et al. showed that low TBIL levels appear to reduce resistance to oxidative stress and contribute to the disruption of lipid metabolism in neonates with nephrotic syndrome. However, the effect of TBIL on the prognosis of infants cannot be judged from data in the literature.

The SOFA score is a well-known scoring system in the ICU setting. It was designed for severity assessments of clinical status and the response examination to a given treatment. Our study shows that the SOFA score was a significant risk factor for in-hospital mortality in the NICU, with 1.483-fold risk of mortality for each 1 point addition. This was in line with the findings of Ha et al. that the sequential assessment of SOFA score within a few days following NICU admission was a good prognostic
predictor in oncology children mechanically ventilated > 3 d, and it was strongly associated with mortality.

As a prognostic device, the nomogram has been extensively used in oncology and medicine to predict the probability of clinical events. It can help clinicians make quick and sound decisions due to the characteristics of better accuracy, straightforward digital interfaces and readily comprehensible prognosis. To the best of our knowledge, this is the first study to construct a nomogram for predicting the risk of in-hospital mortality in the NICU, which simply and easily depicted the associations of each predictor with in-hospital mortality risk. Moreover, the AUC of the present nomogram in predicting neonatal in-hospital mortality was 0.865, showing good predictive accuracy. However, there are still some limitations that needed to be addressed. First, although the sample size retrieved from MIMIC-III database was large enough, the number of neonates in the death group was small, which may affect the statistical power of the current study. Second, MIMIC-III data were from a single medical centre. Additionally, some information, such as maternal height, maternal age, BMI, preterm birth, intrapartum-related complications, education and wealth, was missing in the MIMIC-III database, which may affect the applicability of our predictive model. In the future, more large-scale, multicentre studies on neonatal mortality should be conducted to further verify our results.

Conclusions
Increased RDW and TBIL were associated with a reduced risk of neonatal in-hospital death, while higher lymphocytes, PaCO₂ and SOFA score were related to an increased risk of neonatal in-hospital mortality. The constructed nomogram shows a high accuracy of prediction for in-hospital mortality in the NICU.

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Data availability: The data that support the findings of this study are available from the first author and corresponding author upon reasonable request.

References
1 Wang H, Liddell CA, Coates MM, et al. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384(9947):957–79.
2 Orsido TT, Asseffa NA, Berhebo TM. Predictors of neonatal mortality in neonatal intensive care unit at referral hospital in southern Ethiopia: a retrospective cohort study. BMC Pregnancy Childbirth. 2019;19(1):83.
3 Liu L, Johnson HL, Cousens S, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. Lancet. 2012;379(9832):2151–61.
4 Zee-Vera A, Ochoa TJ. Challenges in the diagnosis and management of neonatal sepsis. J Trop Pediatr. 2015;61(1):1–13.
5 Andegirojish AK, Andemariam M, Temesghen, S, et al. Neonatal mortality and associated factors in the specialized neonatal care unit Asmara. Eritrea. BMC Public Health. 2020;20:10.
6 Mekonnen Y, Tensou B, Telake DS, et al. Neonatal mortality in Ethiopia: trends and determinants. BMC Public Health. 2013;13:48.
7 Lawn JE, Davidge R, Paul VK, et al. Born too soon: care for the preterm baby. Reprod Health. 2013;10(Suppl 1):S1.
8 Akseer N, Lawn JE, Keenon W, et al. Ending preventable newborn deaths in a generation. Int J Gynaecol Obstet. 2015;131(Suppl 1):S43–8.
9 Bhutta ZA, Das JK, Bahl R, et al. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384(9940):347–70.
10 Owusu BA, Lim A, Makaje N, et al. Neonatal mortality at the neonatal unit: the situation at a teaching hospital in Ghana. Afr Health Sci. 2018;18(2):369–77.
11 Li C, Yan H, Zeng L, et al. Predictors for neonatal death in the rural areas of Shaanxi Province of northwestern China: a cross-sectional study. BMC Public Health. 2015;15:387.
12 Houweling TAJ, van Klaveren D, Das S, et al. A prediction model for neonatal mortality in low- and middle-income countries: an analysis of data from population surveillance sites in India, Nepal and Bangladesh. Int J Epidemiol. 2019;48(1):186–98.
13 MIMIC-III Critical Care Database. Available from: https://mimic.mit.edu/about/mimic/ (accessed 28 November 2020).
14 Johnson AE, Pollard TJ, Shen L, et al. MIMIC-III, a freely accessible critical care database. Sci Data. 2016;3:160035.
15 Lambden S, Laterre PF, Levy MM, et al. The SOFA score—development, utility and challenges of accurate assessment in clinical trials. Crit Care. 2019;23:374.
16 Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. JAMA. 1993;270(24):2957–63.
17 Feiner JR, Weiskopf RB. Evaluating pulmonary function: an assessment of PaO₂/FIO₂. Crit Care Med. 2017;45(1):e40–8.
18 Woreta TA, Alqahtani SA. Evaluation of abnormal liver tests. Med Clin North Am. 2019;104(1):1–16.
19 Tunthanathip T, Udomwithayaphibhan S. Development and validation of a nomogram for predicting the mortality after penetrating traumatic brain injury. Bull Emerg Trauma. 2019;7(4):347–54.
20 Martin SI, Desai S, Nanavati R, et al. Red cell distribution width and its association with mortality in neonatal sepsis. J Matern Fetal Neonatal Med. 2019;32(12):1925–30.
21 Eliahyony DM, El-Mekkawy MS, Farag MM. A study of red cell distribution width in neonatal sepsis. Pediatr Emerg Care. 2020;36(8):378–83.
22 Lawn JE, Cousens S, Zupan J, et al. 4 million neonatal deaths: when? where? why? Lancet. 2005;365(9462):891–900.
23 Said AS, Spinella PC, Hartman ME, et al. RBC distribution width: biomarker for red cell dysfunction and critical illness outcome? Pediatr Crit Care Med. 2017;18(2):134–42.
24 Thompson BL, Wyckoff SL, Haverstick DM, et al. Simple, reagentless quantification of total bilirubin in blood via microfluidic phototreatment and image analysis. Anal Chem. 2017;89(5):3228–34.
25 Dani C, Poggi C, Fancelli C, et al. Changes in bilirubin in infants with hypoxic-ischemic encephalopathy. Eur J Pediatr. 2018;177(12):1795–801.
26 Dani C, Poggi C, Pratesi S. Bilirubin and oxidative stress in term and preterm infants. Free Radic Res. 2019;53(1):2–7.
27 Song M, Li A, Gong J, et al. Effects of combined prednisone + fluvastatin on cholesterol and bilirubin in pediatric patients with minimal change nephropathy. Clin Ther. 2013;35(3):286–93.
28 Aperstein Y, Cohen L, Bendavid I, et al. Improved ICU mortality prediction based on SOFA scores and gastrointestinal parameters. PLoS One. 2019;14(9):e0222599.
29 Ha EJ, Kim S, Jin HS, et al. Early changes in SOFA score as a prognostic factor in pediatric oncology patients requiring mechanical ventilatory support. J Pediatr Hematol Oncol. 2010;32(8):e308–13.
30 Sun W, Li G, Liu Z, et al. A nomogram for predicting the in-hospital mortality after large hemispheric infarction. BMC Neurol. 2019;19:347.
31 Balachandran VP, Gonen M, Smith JJ, et al. Nomograms in oncology: more than meets the eye. Lancet Oncol. 2015;16(4):e173–80.