The Richmond Acute Subdural Hematoma Score: A Validated Grading Scale to Predict Postoperative Mortality

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BACKGROUND: Traumatic acute subdural hematomas (aSDHs) are common, life-threatening injuries often requiring emergency surgery.

OBJECTIVE: To develop and validate the Richmond acute subdural hematoma (RASH) score to stratify patients by risk of mortality after aSDH evacuation.

METHODS: The 2016 National Trauma Data Bank (NTDB) was queried to identify adult patients with traumatic aSDHs who underwent craniectomy or craniotomy within 4 h of arrival to an emergency department. Multivariate logistic regression modeling identified risk factors independently associated with mortality. The RASH score was developed based on a factor's strength and level of association with mortality. The model was validated using the 2017 NTDB and the area under the receiver operating characteristic curve (AUC).

RESULTS: A total of 2516 cases met study criteria. The patients were 69.3% male with a mean age of 55.7 yr and overall mortality rate of 36.4%. Factors associated with mortality included age between 61 and 79 yr (odds ratio [OR] = 2.3, $P < .001$), age ≥80 yr (OR = 6.3, $P < .001$), loss of consciousness (OR = 2.3, $P < .001$), Glasgow Coma Scale score of ≤8 (OR = 2.6, $P < .001$), unilateral (OR = 2.8, $P < .001$) or bilateral (OR = 3.9, $P < .001$) unresponsive pupils, and midline shift >5 mm (OR = 1.7, $P < .001$). Using these risk factors, the RASH score predicted progressively increasing mortality ranging from 0% to 94% for scores of 0 to 8, respectively (AUC = 0.72). Application of the RASH score to 3091 cases from 2017 resulted in similar accuracy (AUC = 0.74).

CONCLUSION: The RASH score is a simple and validated grading scale that uses easily accessible preoperative factors to predict estimated mortality rates in patients with traumatic aSDHs who undergo surgical evacuation.

KEY WORDS: Trauma, Subdural hematoma, Acute, Postoperative, Mortality, Outcomes, Model

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Traumatic acute subdural hematomas (aSDHs) result from severe head trauma and are common, life-threatening traumatic injuries.[1-4] In the United States, the overall incidence of aSDH is 40 000 to 67 000 cases per year, with a 30-d mortality ranging from 35% to 52%.[5]

ABBREVIATIONS: aSDH, acute subdural hematoma; **BAC,** blood alcohol content; **ICDs,** International Classification of Diseases; **ICD-10-CM,** ICD, 10th revision, clinical modification; **ICD-10-PCS,** ICD procedure coding system, 10th revision; **IMPACT,** International Mission for Prognosis and Analysis of Clinical Trials in TBI; **LOC,** loss of consciousness; **NTDB,** National Trauma Data Bank; **RASH,** Richmond acute subdural hematoma; **SDH,** subdural hematoma; **TBI,** traumatic brain injury

Surgical evacuation of aSDHs has been shown to improve outcomes.[6] Indications for surgical intervention include hematoma thickness >10 mm, midline shift, asymmetric pupils, and elevated intracranial pressure.[7-12] Postoperative mortality remains high ranging from 27% to 90%.[3,13-15]

Several risk factors for mortality have been identified: coagulopathies, advanced age, low Glasgow Coma Scale (GCS) score, pupil abnormalities, midline shift, elevated intracranial pressure, and ischemic brain damage.[3,16] These factors inform the decision to operate.

Prognostic models can be important adjuncts supporting clinical heuristics. There is no existing model that uses readily available finding to help predict patient outcomes after aSDH evacuation. In this study, the authors develop and validate the

Richmond acute subdural hematoma (RASH) evacuation grading scale as a practical prognostic tool for clinician use.

METHODS

Data Source

The National Trauma Data Bank (NTDB) is a national database of patients with trauma. Details of data collection, quality assurance, and the patient population have been previously reported.[17-19] The American College of Surgeons Committee on Trauma approved the use of the deidentified database for this study. All patient information used in this research was deidentified. Institutional review board approval was obtained for this study, and ethical standards in accordance with the Declaration of Helsinki were maintained.

Patient Selection and Variables

The NTDB was queried to identify adult patients with trauma (>18 yr old), with traumatic subdural hematomas using the *International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM)*, from 2016 to 2017 (Table 1; Figure 1). Patients were filtered to include only those receiving a craniectomy or craniotomy for subdural evacuation using the *ICD Procedure Coding System, 10th Revision (ICD-10-PCS)* (Table 1). Patients were not excluded for complex injuries or multitrauma. Only procedures that were conducted <4 h from arrival to the hospital were included in this study. The data sets from 2016 to 2017 were separated to create and externally validate the grading score model, respectively. Any patients in the 2017 data set who were missing variables necessary to calculate the grading score were removed from the data set.

Variables included for analysis were selected based on previous studies demonstrating a relationship between a factor and morbidity/mortality. All data for the variables, with the exception of loss of consciousness (LOC), were collected within 30 min of patient arrival to the emergency department. LOC was extracted from prearrival and registration data, which were then available in the database as an *ICD-10* code.

Statistical Analysis

Using the 2016 data set, a univariate logistic regression analysis was performed to determine factors associated with mortality. Mortality was defined by discharge disposition of died or discharge to hospice.[17] Factors with $P < .05$ were included in the multivariate logistic regression model. A backward stepwise variable selection method was used to create the final model for factors significantly associated with mortality.

Grading Scale and Validation

The RASH grading scale was created with factors included in the final multivariate model. Each element that remained significant in that model was assigned values of 0, 1, or 2 based on the magnitude of the odds ratio (OR). The sum of all the values gives a RASH score ranging from 0 to 8. The percent distribution of all patients and percent mortality were determined for each score in the grading scale. The percent mortality for each score was used to create both a linear and polynomial regression model. Internal validation of the model consisted of discrimination, which was measured using the area under the receiver operating characteristic curve (AUC), and goodness of fit (R_2 from the regression models).

The grading scale was externally validated using the 2017 data set using the same inclusion criteria. The performance of the model on external validation consisted of goodness of fit with R_2, discrimination using AUC, and calibration (agreement of the observed outcomes with predicted outcomes) using a calibration plot.

RESULTS

Patient and Trauma Characteristics

Of 75 945 patients with a traumatic subdural hematoma in 2016, 5496 received an open subdural evacuation (Figure 1). Of these, 2749 had an intervention performed within 4 h of arrival to the hospital. After inclusion of only adult patients, 2516 patients remained in the sample. In 2017, 3376 patients met criteria.

Patient demographics, hematoma characteristics, and disposition are summarized in Table 2. In 2016, the patients were 69% male and 72% White. Patients were grouped into ages 18 to 60 (52%), 60 to 79 (36%), and >80 (12%) yr. Most of the evacuated aSDHs were supratentorial (97%), >11 mm in diameter (58%), and unilateral (86%) with <5 mm midline shift (82%). GCS severity on arrival was mild (>14) (62%), moderate (9-13) (14%), and severe (<8) (23%). LOC occurred in 80% of the patients. In this patient population, there was 36% mortality during hospital stay. Surviving patients were discharged to inpatient rehabilitation (26%), home (14%), skilled nursing facility (11%), or other (12%).

Risk Factors for Mortality

Univariate ORs are presented in Table 3. The following risk factors were associated with mortality: age between 61 and 79 yr (OR = 1.5, $P \leq .0001$) or older than 80 yr (OR = 2.2, $P \leq .0001$), hematoma thickness >11 mm (OR = 1.6, $P = .0446$) with a midline shift >5 mm (OR = 2.1, $P \leq .0001$), moderate GCS severity (OR = 1.6, $P = .0036$), severe GCS severity (OR = 3.5, $P \leq .00001$), loss of consciousness (LOC) (OR = 2.3, $P \leq .0001$), nonreactive pupils unilaterally (OR = 2.8, $P \leq .0001$) or bilaterally (OR = 4.7, $P \leq .0001$), ventilation (OR = 1.8, $P \leq .0001$), blood

TABLE 1. *ICD-10* Codes for Traumatic Subdural Hematoma and Open Subdural Evacuation

Category	Name	*ICD-10* code
Diagnosis (*ICD-10-CM*)	Traumatic subdural hematoma	S06.5X0A, S06.5X1A, S06.5X2A, S06.5X3A, S06.5X4A, S06.5X5A, S06.5X6A, S06.5X7A, S06.5X8A, S06.5X9A
Procedure (*ICD-10-PCS*)	Open subdural evacuation	00940ZZ, 00C40ZZ

ICD, International Classification of Diseases; *ICD-10-CM, ICD, 10th revision, clinical modification; ICD-10-PCS, ICD, 10th revision, procedure coding system.*

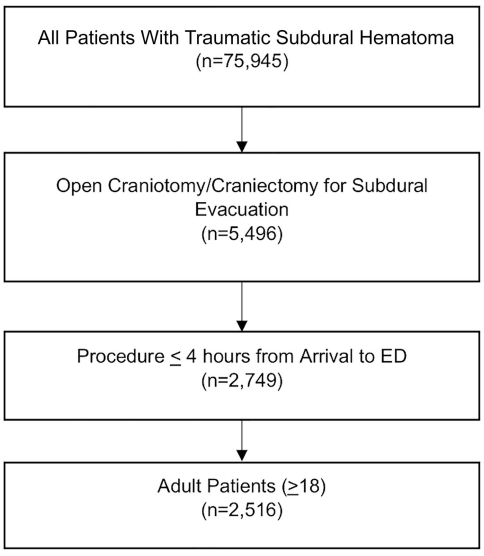

FIGURE 1. *Patient selection and criteria from the 2016 National Trauma Data Bank. ED, emergency department.*

alcohol content (BAC) >0.08 (OR = 0.1, P = .003), and respiratory rate (OR = 0.9, P = .0072). Sex, pulse rate, O_2 saturation, and systolic blood pressure were not significantly associated with mortality.

Multivariate ORs for the factors associated with mortality on univariate analysis are presented in Table 3. Ages 61 to 79 yr (OR = 2.2, $P \leq .0001$) and >80 yr (OR = 6.3, $P \leq .001$), midline shift >5 mm (OR = 1.7, P = .023), nonreactive pupils unilaterally (OR = 2.8, $P \leq .0001$) and bilaterally (OR = 4.1, $P \leq .0001$), severe GCS (OR = 2.4, $P \leq .0001$), and LOC (OR = 2.3, $P \leq .0001$) all remained associated with increased mortality.

RASH Grading Scale

The RASH grading scale was developed based on the factors independently associated with mortality (Table 4). Factors included age, GCS severity, pupillary response, midline shift >5 mm, and LOC. Each factor was assigned a numerical value of 0, 1, or 2. A patient's RASH score is the sum of the numerical values for each factor and ranges from 0 to 8. The patient distribution and mortality of the RASH grading scale are presented in Figure 2 and Table 5. The mortality ranged from 0% to 88% for RASH scores of 0 and 8, respectively. The RASH score of 58% of patients was between 3 and 5. The AUCs for the 2016 and 2017 data are 0.72 and 0.74, respectively.

A polynomial model ($y = 0.58x^2 + 6.57x$, $R^2 = 0.99$) and linear model ($y = 10.3x$, $R^2 = 0.97$) were created to predict mortality for each score in the grading scale (Figure 3). Both models were externally validated using the 2017 patient sample (Figure 3; Table 6). The polynomial model predicts mortality ranging from 0% to 90% for RASH scores 0 to 8. The linear model predicts mortality ranging from 0% to 82% for RASH scores 0 to 8.

TABLE 2. Patient Characteristics from 2016 to 2017 Including Mean (With Standard Deviation) and Frequency (With Percent)

	Mean (SD), freq (%)	
	2016	2017
N	2516	3376
Age (yr)		
18-60	1316 (52.31)	1639 (13.51)
60-79	897 (35.65)	1210 (36.73)
≥80	303 (12.04)	445 (49.76)
Sex		
M	1743 (69.28)	2278 (69.16)
F	773 (30.72)	1016 (30.84)
Race		
White	1808 (71.86)	2458 (74.62)
Black	290 (11.53)	313 (9.50)
Asian	74 (2.94)	116 (3.52)
Other	344 (13.67)	489 (12.36)
BAC ≥.08		
N	1601 (63.63)	1690 (76.47)
Y	915 (36.37)	520 (23.54)
Hematoma location		
Supratentorial	2367 (97.41)	3157 (98.29)
Infratentorial	63 (2.59)	55 (1.71)
Hematoma thickness (mm)		
≤5	89 (3.54)	130 (3.95)
6-10	507 (20.15)	611 (18.55)
≥11	1467 (58.31)	2049 (62.20)
Unknown	453 (18.00)	504 (15.30)
Bilateral hematoma		
N	2155 (85.65)	2794 (84.82)
Y	361 (14.35)	500 (15.18)
GCS score		
Mild (≥14)	1527 (62.61)	1969 (61.76)
Moderate (9-13)	346 (14.19)	485 (15.21)
Severe (≤8)	566 (23.21)	734 (23.02)
Hours to surgical evacuation	2.15 (0.85)	2.16 (0.83)
Pupillary response		
Responsive	1332 (64.44)	2008 (66.67)
Nonresponsive—unilateral	212 (10.26)	245 (8.13)
Nonresponsive—bilateral	523 (25.30)	759 (25.20)
Midline shift >5 mm		
N	1740 (81.92)	2582 (83.69)
Y	384 (18.08)	503 (16.31)
Loss of consciousness		
N	497 (19.75)	649 (19.70)
Y	2019 (80.25)	2645 (80.30)
Ventilator		
N	1455 (57.83)	1839 (57.76)
Y	1061 (42.17)	1345 (42.24)
Hospital disposition		
Died	801 (31.84)	1078 (32.76)
Discharged to hospice	114 (4.53)	173 (5.26)
Discharged to inpatient rehabilitation	656 (26.07)	818 (24.86)
Discharged to SNF	288 (11.45)	402 (12.22)
Discharged to home	357 (14.19)	330 (10.03)
Other	300 (11.92)	572 (14.87)
Mortality	915 (36.36)	1251 (37.39)

BAC, blood alcohol content; GCS, Glasgow Coma Scale; SNF, skilled nursing facility.

TABLE 3. Univariate and Multivariate OR for 2016 Patient and Hematoma Factors With 95% Confidence Interval (in Brackets) and *P* Value (in Parentheses)

	Univariate OR	Multivariate OR
Age (yr)		
18-60	1.0 (ref)	1.0 (ref)
61-79	1.5 [1.3-1.8] (<.0001)	2.2 [1.8-2.8] (<.0001)
≥80	2.2 [1.7-2.7] (<.0001)	6.3 [4.4-8.9] (<.0001)
Sex		
F	1.0 (ref)	
M	0.90 [0.73-1.0] (.09)	
BAC >.08	0.73 [0.59-0.89] (.003)	0.79 [0.61-1.03] (.077)
Loss of consciousness	2.3 [1.9-2.8] (<.0001)	2.3 [1.5-2.6] (<.0001)
Hematoma size (mm)		
≤5	1.0 (ref)	1.0 (ref)
6-10	0.85 [0.54-1.3] (.49)	0.66 [0.38-1.17] (.155)
≥11	1.6 [1.0-2.4] (.044)	0.99 [0.59-1.69] (.997)
Hematoma location		
Supratentorial	1.0 (ref)	
Infratentorial	0.75 [0.45-1.3] (.27)	
Midline shift >5 mm		
N	1.0 (ref)	1.0 (ref)
Y	2.1 [1.7-2.7] (<.0001)	1.7 [1.3-2.2] (.0004)
GCS severity		
Mild (≥14)	1.0 (ref)	
Moderate (9-13)	1.6 [1.2-2.2] (.004)	1.3 [0.90-1.9] (.16)
Severe (≤8)	3.5 [2.8-4.4] (<.0001)	2.4 [1.7-3.2] (<.0001)
Pupillary response		
Normal	1.0 (ref)	
Nonreactive—unilateral	2.8 [2.2- 3.8] (<.0001)	2.8 [2.0-3.9] (<.0001)
Nonreactive—bilateral	4.7 [3.9-5.8] (<.0001)	4.2 [3.2-5.3] (<.0001)
Ventilator	1.8 [1.5-2.1] (<.0001)	0.87 [0.68-1.12] (.29)
O_2 saturation	0.99 [0.99-1.00] (.34)	
Pulse	1.00 [0.99-1.00] (.38)	
Respiratory rate	0.99 [0.98-0.99] (.007)	0.99 [0.99-1.01] (.78)
Systolic blood pressure	1.0 [1.0-1.0] (.13)	

BAC, blood alcohol content; GCS, Glasgow Coma Scale; OR, odds ratio.

Calibration plots demonstrate that the polynomial model predicts mortality better than the linear model in both 2016 and 2017 (Figure 4). The linear models tend to overestimate at lower RASH scores and underestimate at higher RASH scores.

The RASH model's performance was assessed by comparing the AUC with other commonly used predictors in traumatic brain injury (TBI) and the International Mission for Prognosis and Analysis of Clinical Trials in TBI (IMPACT) score model (Table 7). Predictors included in the analysis were age (AUC = 0.60), midline shift >5 mm (AUC = 0.54), pupillary response (AUC = 0.64), LOC (AUC = 0.54), GCS score (AUC = 0.65), and hematoma thickness (AUC = 0.55). The IMPACT score AUC was 0.76, and the RASH score AUC was 0.74.

DISCUSSION

This study creates a novel grading scale to predict postoperative mortality in patients who undergo evacuation of traumatic aSDHs. The model uses 5 factors immediately available in the trauma setting (age, GCS, pupillary response, midline shift, and LOC) to predict postoperative mortality. Compared with existing models, the RASH score's simplicity and efficiency allow for its practical use in an emergent setting by providers.

The use of the NTDB allowed us to obtain a large sample size across all nationally participating trauma centers. In 2016, a total of 2516 patients met criteria for this study and were used to create the model. In 2017, a total of 3376 patients met criteria for this study and were used for external validation of the model.

We found that 36% of the patients who present with traumatic aSDHs and receive open surgical intervention die during their stay. This percentage is likely underestimated because it does not consider mortality after discharge from the hospital. Previous studies have shown a postoperative mortality ranging from 50% to 90% for aSDHs, although many of these studies were conducted several decades ago.[3,7,13-15] A recent study from 2017 found postoperative mortality was 27% in a cohort of 2498 patients.[14]

The RASH score was developed based on risk factors independently associated with mortality, and age, pupillary response, GCS, midline shift, and LOC were independently associated with mortality. These risk factors are consistent with many previous studies.[6,12,14,20-25]

The RASH model assigns these risk factors a value from 0 to 2 for a total score from 0 to 8 (Table 4). Decisions on weighting the elements of the RASH score were guided by the magnitude of the ORs, balanced by a desire to maintain simplicity. Higher scores could have been assigned to pupillary response and age, but weighting those elements more heavily was found not to significantly improve the predictiveness of the RASH score.

TABLE 4. RASH Grading Scale Ranges from 0 to 8 Based on Age, GCS Score, Pupil Response, Midline Shift, and Posttraumatic Loss of Consciousness

RASH score	
Age (yr)	
≤59	0
60-79	1
≥80	2
GCS severity	
Mild (≥14)	0
Moderate (9-13)	1
Severe (≤8)	2
Pupillary response	
Unresponsive, unilateral	1
Unresponsive, bilateral	2
Midline shift >5 mm	1
Loss of consciousness	2
Total	0-8

GCS, Glasgow Coma Scale; RASH, Richmond acute subdural hematoma.

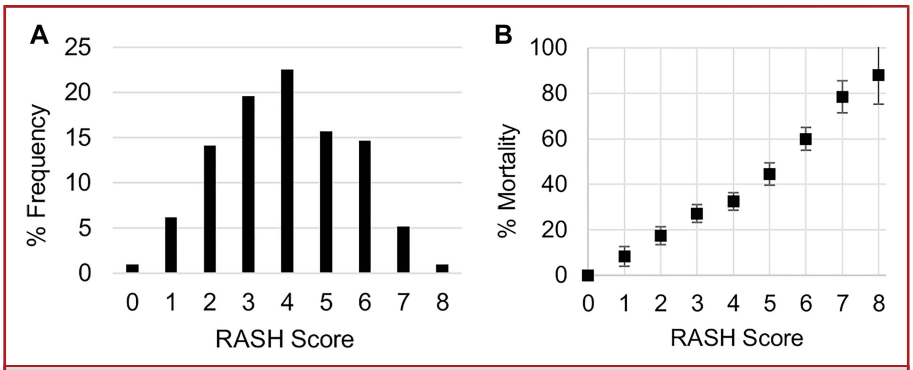

FIGURE 2. *Percent frequency of patients* **A** *and percent mortality* **B** *by RASH score for 2016 patient data. RASH, Richmond acute subdural hematoma.*

Most patients had a midrange RASH score (3-5). Only 1% of the patients were in the extremes of the score (RASH score 0 or 8). We predict that patients with a RASH score of 0 or 8 are not likely to receive open evacuation for the SDH and account for a low percentage of patients assigned to that score.

Two types of regression models were applied to the grading scale to predict mortality, a linear and a polynomial model (Table 6; Figures 3 and 4). Although the polynomial model fits the data better, the benefit of the linear model is in how promptly it allows the estimation of the predicted mortality. The linear model equation ($y = 10.3x$) allows for the predicted mortality to be calculated by multiplying the RASH score by 10. For example, a RASH score of 3 has roughly a 30% predicted mortality, whereas a score of 8 has an 80% predicted mortality. Therefore, the linear model could be used to quickly predict chance of mortality, whereas the polynomial model would provide a more accurate prediction.

Grading scales to predict morbidity and mortality in TBI are widely used. One of the earliest grading scales used in TBI, the GCS, has been used for several decades and remains one of the strongest predictors of functional outcome and mortality.[26-28] Our study demonstrates that the RASH grading scale (AUC = 0.74) has better performance for predicting mortality than any of the factors individually, including GCS (AUC = 0.65).

The IMPACT and corticosteroid randomization after significant head injury trials led to the development of 2 well-validated TBI grading scales.[29,30] Similar to our scoring system, age, GCS, pupil responsiveness, and various computed tomography findings are included in the prognostic calculators. When compared with the IMPACT core model, the RASH score had a comparable AUC (0.76 and 0.74, respectively).

The NTDB variables used in the RASH score were all collected within 30 min of initial patient presentation. Therefore, the measurements of the variables in the RASH score should also be collected immediately on patient arrival to the emergency department to be most accurately used in the model. Age, GCS score, and pupillary response can all be gathered on quick evaluation of the patient. LOC after the trauma may be obtained from the patient, emergency medical services, or bystander. LOC is defined as any period with loss of awareness of self or surroundings.

Our model differs in several important respects from previously developed models. Importantly, the RASH model is internally and externally validated specifically for aSDHs, allowing clinicians to confidently use the scoring system to predict mortality in this subpopulation of TBIs. The RASH model was specifically designed to be used on initial patient presentation and keeping the calculation to predict mortality simple, bearing in mind the urgency underlying the decision to undergo operative intervention. The simple scoring system from 0 to 8 allows for additional outcome analysis, such as hospital complications, functional outcome, and length of hospital stay, to be performed based on a patient's RASH score.

Limitations

This study has several limitations. This scoring system was created and validated on patient samples provided by the NTDB. The study may therefore have a sample bias due to the nature of the sample gathered from the NTDB and retrospective studies in

TABLE 5. Frequency (%) Distribution and Mortality by RASH Score for 2016 Patient Data

RASH	Distribution (%)	Mortality (%)
0	24 (1.0)	0 (0.0)
1	156 (6.2)	13 (8.3)
2	356 (14.1)	62 (17.4)
3	493 (19.6)	134 (27.2)
4	567 (22.5)	184 (32.5)
5	395 (15.7)	176 (44.6)
6	370 (14.7)	222 (60.0)
7	130 (5.2)	102 (78.5)
8	25 (1.0)	22 (88.0)

RASH, Richmond acute subdural hematoma.

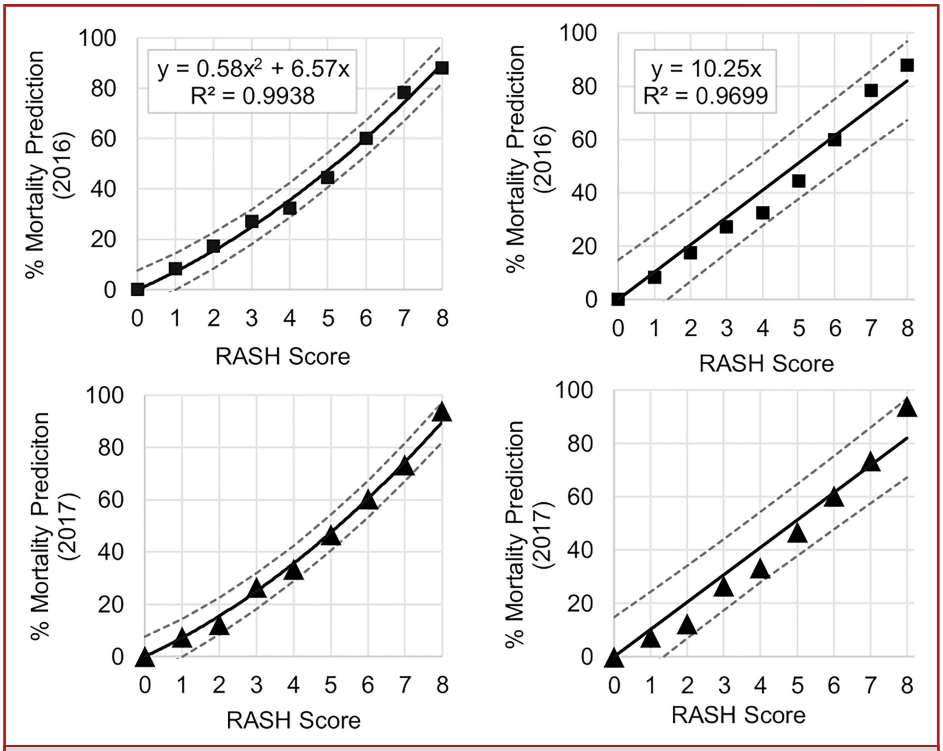

FIGURE 3. *Predicted percent mortality (black solid line) with 95% confidence intervals (dotted line) and actual 2016 (square symbol) and 2017 (triangle symbol) percent mortality. The top row is mortality prediction for 2016 patient data and the bottom row is mortality prediction for 2017 patients with polynomial equation (left column) and linear equation (right column). RASH, Richmond acute subdural hematoma.*

general. For example, the NTDB collects data only from participating trauma centers, which excludes all nonparticipating trauma centers.[31-33] There may be significant underreporting, selection bias, measurement bias, or systematic data collection bias. One of the aims of future projects is to validate the scoring system on a retrospective sample from a single level 1 trauma center.

The NTDB does not provide many relevant laboratory values, eg, blood glucose, international normalized ratio, or platelet counts, which have been associated with mortality in patients with TBI. In addition, although the *ICD-10* codes are specific to traumatic subdural hematomas (SDHs), some patients may present with acute-on-chronic hematomas, which can alter surgical decision-making and create additional bias in the patients

TABLE 6. External Validation of Model Using 2017 Patient Data

RASH	% Actual mortality	% Predicted mortality (polynomial)	Δ	% Predicted mortality (linear)	Δ
0	0.0	0.0	0.00	0.0	0.00
1	7.3	7.2	0.19	10.2	−2.90
2	12.3	15.5	3.19	20.5	−8.22
3	26.6	24.9	1.68	30.7	−4.14
4	33.4	35.5	2.17	41.0	−7.61
5	46.7	47.3	0.63	51.2	−4.55
6	60.4	60.3	0.09	61.5	−1.14
7	73.4	74.4	0.95	71.7	1.67
8	93.9	89.6	4.34	82.0	11.96

Actual percent mortality and predicted percent mortality (polynomial and linear) by Richmond acute subdural hematoma score.

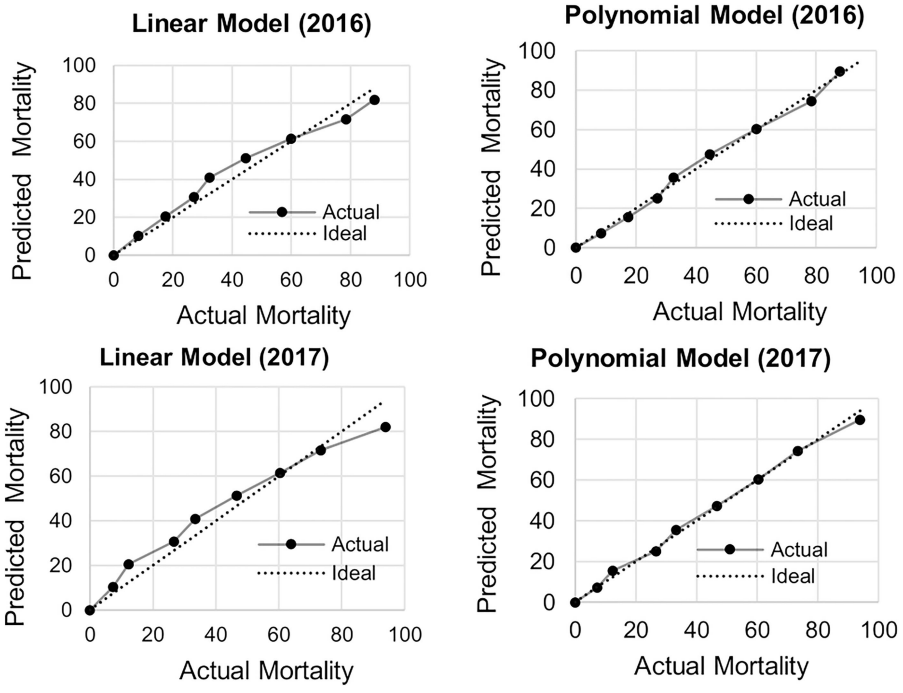

FIGURE 4. *Internal (2016) and external (2017) validity for the Richmond acute subdural hematoma linear and polynomial model for prediction of mortality. Actual (solid) and ideal (dotted) curves for predicted vs actual mortality.*

included in this study. The patients are unlikely to have solely chronic SDH because this is a distinct *ICD-10* code that was not included in this study. LOC is another data point that is limited by *ICD-10* coding and may be underrepresented in this data set. However, the 4-hr cutoff to surgery was intended to include only acutely and significantly injured patients, hopefully excluding the patients with largely chronic components.

Another limitation of the NTDB is the lack of long-term follow-up. The NTDB only includes in-hospital mortality or hospice discharge. The model is used to predict mortality, but it may also underpredict mortality by only considering patients who died during their hospital stay. In addition, the NTDB does not contain functional outcomes.

Although not a limitation, it should be noted that the model was created based on patients who received surgical intervention and therefore cannot be applied to all patients presenting with aSDHs. Finally, this scoring system is not intended to replace clinical judgment, and the authors do not suggest a cutoff at which not to operate. Rather, the scoring system can be used to aid family discussions and as a component of decision-making.

TABLE 7. AUCs for Variables and Models Predicting Hospital Mortality in the NTDB 2017 Population Data

Predictors/Model	Values	AUC
Age (yr)	0-99	0.60
Midline shift >5 mm	<5 mm >5 mm	0.54
Pupillary response	Responsive Nonresponsive—unilateral Nonresponsive—bilateral	0.64
LOC	Y/N	0.54
GCS	3-15	0.65
Hematoma thickness	≤5 mm 6-10 mm ≥11 mm	0.55
IMPACT	0-15	0.76
RASH	0-8	0.74

AUC, area under the receiver operating characteristic curve; GCS, Glasgow Coma Scale; IMPACT, International Mission for Prognosis and Analysis of Clinical Trials in TBI; LOC, loss of consciousness; NTDB, National Trauma Data Bank; RASH, Richmond acute subdural hematoma; TBI, traumatic brain injury.

CONCLUSION

The RASH model is a validated prognostic model that uses factors readily in an emergent setting to quickly predict post-operative outcomes in patients who present with traumatic aSDHs. The RASH score ranges from 0 to 8, with the predicted postoperative mortality risk calculated by multiplying the RASH

score by 10. Accurate prediction of postoperative mortality may guide patient stratification and discussions for goals of care. In this setting, the RASH score may be useful to neurosurgeons, trauma surgeons, emergency physicians, and neurointensivists. Future studies will investigate the utility of the RASH score to predict mortality in broader patient populations, such as all patients with aSDH (with and without intervention) and TBI.

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COMMENTS

The Richmond acute subdural hematoma (RASH) score sounds a little too much like the "corticosteroid randomization after significant head injury (CRASH) score." It is, though, facile to calculate and has highly desirable properties such as the ability to multiply the score by 10 and approximate the risk of mortality. In fact, its metrics are sufficiently perfect that I worry the model might be overfit. Most concerning to me is that the model has only been validated in the same research database from which it was generated—I will not give it much further thought until it is more extensively validated. I am also not a fan of the "loss of consciousness" variable, as it is highly prevalent and highly confounded.

Given our improving ability to prognosticate TBI, I am very troubled that we are not talking and thinking enough about what to do with the prognostic calculations. What is a good outcome? Should a patient with a sufficiently good prognosis be subject to a "Nihilism Guard"[1] and if so at what threshold? How accurate must outcome prediction be to strongly

influence care decisions? Although these judgments are more philosophical and moral than scientific, it is high time that we better informed them. I believe that there should be an effort to constrain the variability in decisions related to limitations of care. But perhaps I am completely wrong, and it is highly appropriate for us to continue ignoring this gap in the literature as these decisions are wholly up to the patients' well-informed substitute decision makers and not us.

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