MULTI-CENTER VALIDATION OF A SIMPLIFIED SCORE TO PREDICT MASSIVE TRANSFUSION

Bryan A Cotton, MD, MPH,[1] Lesly A Dossett, MD, MPH,[2]
Elliott R Haut, MD,[3] Shahid Shafi, MD, MPH,[4]
Lt. Col. Timothy C Nunez, MD,[5] Brigham K Au, MD,[2]
Patrick Arbogast, PhD,[2] Pampee P Young, MD, PhD [6]

[1] Dept of Surgery-University Texas Health Science Center, Houston, TX
[2] Dept of Biostatistics, Vanderbilt University, Nashville, TN
[3] Dept of Surgery, The Johns Hopkins Hospital, Baltimore, MD
[4] Dept of Surgery, University of Texas-Southwestern, Dallas, TX
[5] Dept of Surgery, Brooke Army Medical Center, San Antonio, TX
[6] Dept of Pathology, Vanderbilt University, Nashville, TN

Background

- Massive transfusion: ≥ 10 U blood in 24 hr
- 8-10% patients in military setting and 3-5% civilian setting receive MT
- Civilian and military centers implemented programs to rapidly address these patients

Background

Damage Control Hematology: The Impact of a Trauma Exsanguination Protocol on Survival and Blood Product Utilization

Bryan A. Cotton, MD, Oliver L. Gunter, MD, James Isbell, MD, Brigham K. Au, BS, Amy M. Robertson, MD, John A. Morris, Jr., MD, Paul St. Jacques, MD, and Pampee P. Young, MD, PhD

Background: The importance of early and aggressive management of trauma-related coagulopathy remains poorly understood. We hypothesized that a trauma exsanguination protocol (TEP) that systematically provides specified numbers and types of blood components immediately upon initiation of resuscitation would improve survival and reduce overall blood product consumption among the most severely injured patients.

Methods: We recently implemented a TEP, which involves the immediate and continued release of blood products from the blood bank in a predefined ratio of 10 units of packed red blood cells (PRBC) to 4 units of fresh frozen plasma to 2 units of platelets. All TEP activations from February 1, 2006 to July 31, 2007 were retrospectively evaluated. A comparison cohort (pre-TEP) was selected from all trauma admissions between August 1, 2004 and January 31, 2006 that (1) underwent immediate surgery by the trauma team and (2) received greater than 10 units of PRBC in the first 24 hours. Multivariable analysis was performed to compare mortality and overall blood product consumption between the two groups.

Results: Two hundred eleven patients met inclusion criteria (117 pre-TEP, 94 TEP). Age, sex, and Injury Severity Score were similar between the groups, whereas physiologic severity (by weighted Revised Trauma Score) and predicted survival (by trauma-related Injury Severity Score, TRISS) were worse in the TEP group (p values of 0.037 and 0.028, respectively). After controlling for age, sex, mechanism of injury, TRISS and 24-hour blood product usage, there was a 74% reduction in the odds of mortality among patients in the TEP group ($p = 0.001$). Overall blood product consumption adjusted for age, sex, mechanism of injury, and TRISS was also significantly reduced in the TEP group ($p = 0.015$).

Conclusions: We have demonstrated that an exsanguination protocol, delivered in an aggressive and predefined manner, significantly reduces the odds of mortality as well as overall blood product consumption.

Key Words: Hemorrhage, Exsanguination, Trauma, Massive transfusion.

J Trauma. 2008;64:1177–1183.

Background

Predefined Massive Transfusion Protocols are Associated With a Reduction in Organ Failure and Postinjury Complications

Bryan A. Cotton, MD, Brigham K. Au, BS, Timothy C. Nunez, MD, Oliver L. Gunter, MD, Amy M. Robertson, MD, and Pampee P. Young, MD, PhD

Introduction: Massive transfusion (MT) protocols have been shown to improve survival in severely injured patients. However, others have noted that these higher fresh frozen plasma (FFP): red blood cell (RBC) ratios are associated with increased risk of organ failure. The purpose of this study was to determine whether MT protocols are associated with increased organ failure and complications.

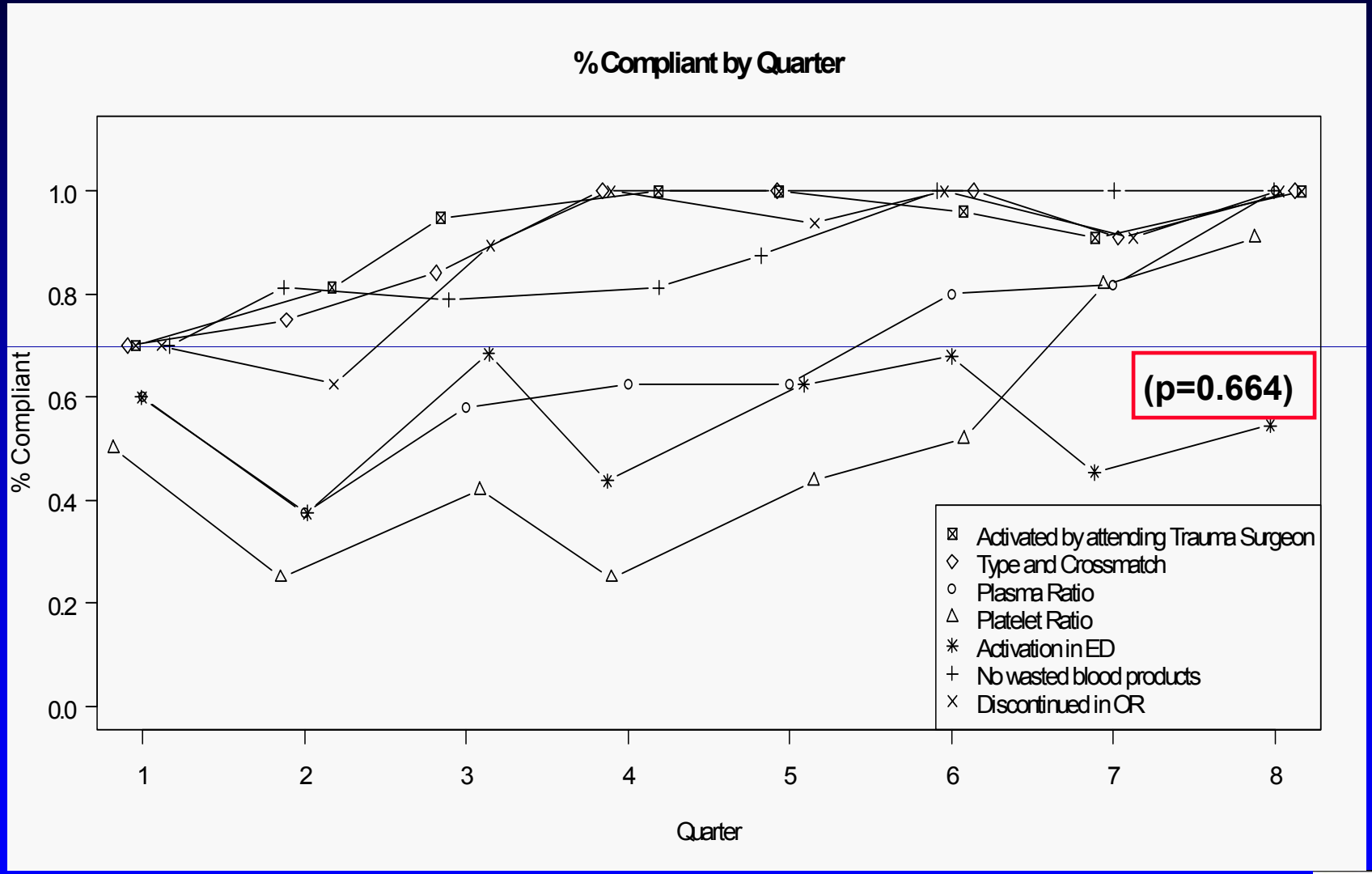
Methods: Our institution's exsanguination protocol (TEP) involves the immediate delivery of products in a 3:2 ratio of RBC:FFP and 5:1 for RBC:platelets. All patients receiving TEP between February 2006 and January 2008 were compared with a cohort (pre-TEP) of all patients from February 2004 to January 2006 that (1) went immediately to the operating room and (2) received MT (≥10 units of RBC in first 24 hours).

Results: Two hundred sixty-four patients met inclusion (125 in the TEP group, 141 in the pre-TEP). Demographics and Injury Severity Score were similar. TEP received more intraoperative FFP and platelets but less in first 24 hours ($p < 0.01$). There was no difference in renal failure or systemic inflammatory response syndrome, but pneumonia, pulmonary failure, open abdomens, and abdominal compartment syndrome were lower in TEP. In addition, severe sepsis or septic shock and multiorgan failure were both lower in the TEP patients (9% vs. 20%, $p = 0.011$ and 16% vs. 37%, $p < 0.001$, respectively).

Conclusions: Although MT has been associated with higher organ failure and complication rates, this risk appears to be reduced when blood products are delivered early in the resuscitation through a predefined protocol. Our institution's TEP was associated with a reduction in multiorgan failure and infectious complications, as well as an increase in ventilator-free days. In addition, implementation of this protocol was followed by a dramatic reduction in development of abdominal compartment syndrome and the incidence of open abdomens.

Key Words: Hemorrhage, Exsanguination, Trauma, Massive transfusion.

J Trauma. 2009;66:000–000.


% Compliant by Quarter
% Compliant
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
Quarter
(p=0.664)
Activated by attending Trauma Surgeon
Type and Crossmatch
Plasma Ratio
Platelet Ratio
Activation in ED
No wasted blood products
Discontinued in OR

PI/QI

Table 5. Outcomes by individual PI measure compliance

24-hour survival			
	Compliant	Non-compliant	p-value
Type and screen sent from ED	70%	58%	0.415
TEP activation in ED	77%	58%	***0.023***
TEP activated by attending	69%	60%	0.514
2:3 plasma: RBC ratio achieved	86%	33%	***<0.001***
1:5 platelet: RBC ratio achieved	88%	51%	***<0.001***
30-day survival			
Type and screen sent from ED	58%	50%	0.617
TEP activation in ED	69%	42%	***0.002***
TEP activated by attending	58%	40%	0.102
2:3 plasma: RBC ratio achieved	77%	17%	***<0.001***
1:5 platelet: RBC ratio achieved	81%	34%	***<0.001***

EAST Podium presentation January 2009

Need for a scoring system

- Many centers have implemented protocols
- Few have standardized policies for activation
- Several investigators have developed scores to rapidly identify patients who require MT

Scoring Methods

- TASH and the McLaughlin scores reliably predict the need for massive transfusion
- However, neither score is feasible for “real-time” use in exsanguinating hemorrhage patients
- Both are weighted and also rely on laboratory values and or injury severity score calculations

TASH

Variable	Value	Points
Hemoglobin (mg/dL)	<7	8
	<9	6
	<10	4
	<11	3
	<12	2
Base excess (mmol/L)	<−10	4
	<−6	3
	<−2	1
Systolic blood pressure (mm Hg)	<100	4
	<120	1
Heart rate (beats/min)	>120	2
Free intraabdominal fluid (e.g. by FAST)		
Extremities		3
Clinically instable pelvic fracture		6
Clinically femur fracture open/dislocated		3
Male patient		1

FAST, focused assessment sonography in trauma.

TASH Score

- The probability for mass transfusion associated with the TASH-Score points was calculated by the following logistic function:

$$p = 1/[1 + \exp(4.9 - 0.3 * TASH)]$$

McLaughlin Score

- McLaughlin score 4 components: HR >105 bpm, SBP < 110 mmHg, pH < 7.25, and Hct < 32%
- Variables assigned values 0 or 1 based on whether or not the value is classed as predictive
- The final predictive equation was:

$$\log(p/[1 - p]) = 1.576 + (0.825 * SBP) + (0.826 * HR) + (1.044 * Hct) + (0.462 * pH)$$

ABC Score

- Four (4) dichotomous components available during the “A-B-C’s”
- The presence of any one component contributes one point to the total score (range 0-4)
- Parameters: Penetrating MOI (0=no, 1=yes), ED SBP ≤ 90mmHg (0=no, 1=yes), ED HR ≥120 bpm (0=no, 1=yes), (+) FAST (0=no, 1=yes)

Pilot study

Early Prediction of Massive Transfusion in Trauma: Simple as ABC?

Timothy C. Nunez, MD, Igor V. Voskresensky, MD, Lesly A. Dossett, MD, MPH, Ricky Shinall, BS, William D. Dutton, MD, and Bryan A. Cotton, MD

Background: Massive transfusion (MT) occurs in about 3% of civilian and 8% of military trauma patients. Although many centers have implemented MT protocols, most do not have a standardized initiation policy. The purpose of this study was to validate previously described MT scoring systems and compare these to a simplified nonlaboratory dependent scoring system (Assessment of Blood Consumption [ABC] score).

Methods: Retrospective cohort of all level I adult trauma patients transported directly from the scene (July 2005 to June 2006). Trauma-Associated Severe Hemorrhage (TASH) and McLaughlin scores calculated according to published methods. ABC score was assigned based on four nonweighted parameters: penetrating mechanism, positive focused assessment sonography for trauma, arrival systolic blood pressure of 90 mm Hg or less, and arrival heart rate ≥120 bpm. Area under the receiver operating characteristic curve (AUROC) used to compare scoring systems.

Results: Five hundred ninety-six patients were available for analysis; and the overall MT rate of 12.4%. Patients receiving MT had higher TASH (median, 6 vs. 13; $p < 0.001$), McLaughlin (median, 2.4 vs. 3.4; $p < 0.001$) and ABC (median, 1 vs. 2; $p < 0.001$) scores. TASH (AUROC = 0.842), McLaughlin (AUROC = 0.846), and ABC (AUROC = 0.842) scores were all good predictors of MT, and the difference between the scores was not statistically significant. ABC score of 2 or greater was 75% sensitive and 86% specific for predicting MT (correctly classified 85%).

Conclusions: The ABC score, which uses nonlaboratory, nonweighted parameters, is a simple and accurate in identifying patients who will require MT as compared with those previously published scores.

Key Words: Hemorrhage, Trauma, Massive transfusion, Prediction, Scoring systems.

ABC Score

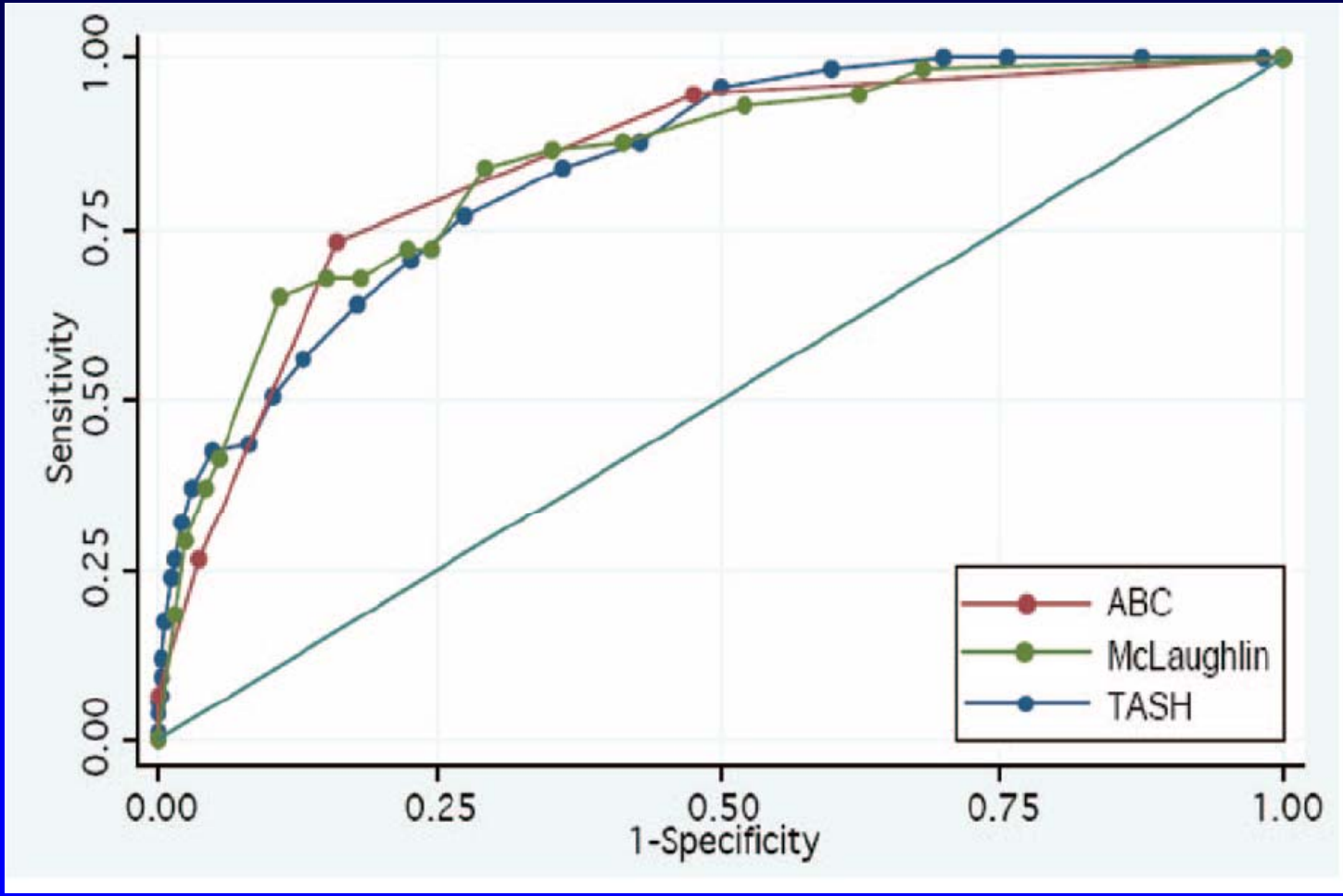

Sensitivity
0.00
0.25
0.50
0.75
1.00
1-Specificity
0.00
0.25
0.50
0.75
1.00
ABC
McLaughlin
TASH

Table 3 Sensitivity, Specificity, and Percent Correctly Classified for ABC Score Cutpoints

Cutpoint	Sensitivity (%)	Specificity (%)	Correctly Classified (%)
≥0	100	0	13
≥1	95	56	61
≥2	75	86	84
≥3	25	97	87
≥4	6	100	88

Purpose

To validate the ability of the ABC score to predict massive transfusion at three level 1 trauma centers with diverse patient populations

Methods-Setting

- Southwestern/Parkland Hospital
- Vanderbilt University Medical Center
- Johns Hopkins Hospital

Methods-Data Sources

- TRACS database for each institution
- All patients arriving as level I alerts
- All adult patients (≥ 18 yo)
- Admitted 07/01/06-06/30/07

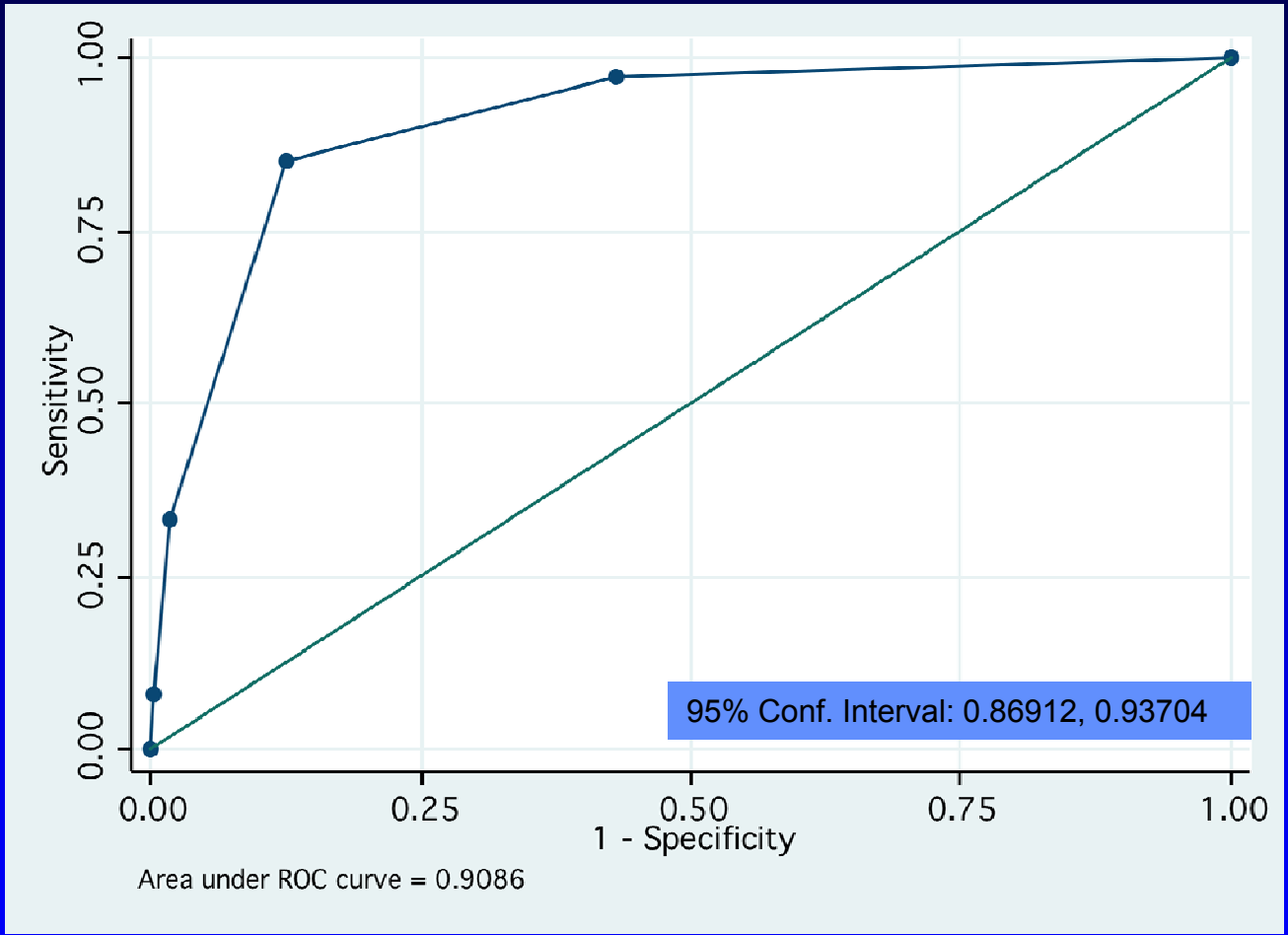
Methods-Data Sources

- Coordinating center IRB
- Individual center IRB
- Data sharing agreement

Demographics-baseline data

	VUMC (n=513)	UTSW (n=372)	JHH (n=133)
Median age, years (IQR)	38 (25, 53)	36 (26, 53)	30 (22, 43)
Median ISS (IQR)	24 (11, 35)	19 (14, 28)	22 (11, 33)
Penetrating mechanism, %	19%	23%	59%
Male gender, %	76%	75%	86%
Massive transfusion, %	14%	15%	15%
Median initial SBP (IQR)	120 (98, 140)	120 (98, 144)	108 (82, 123)
Median initial HR (IQR)	98 (84, 119)	98 (81, 119)	104 (89, 122)
Positive FAST, %	16%	19%	15%
Race-white, %	78%	35%	15%
Median ABC score (IQR)	1 (0, 1)	1 (0, 1)	1 (1, 2)

ABC Score-VUMC



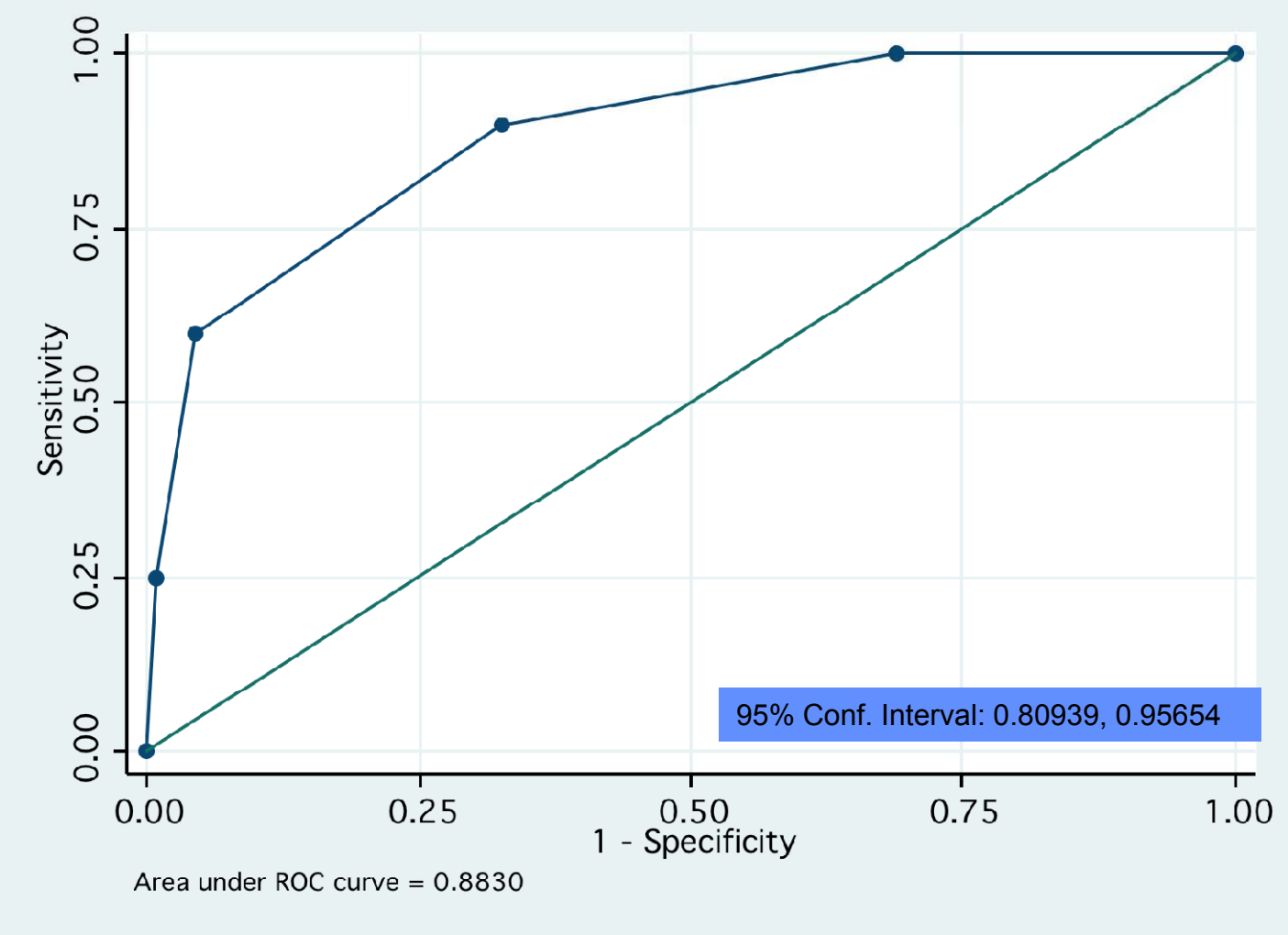
ABC Score-VUMC

Cut-point	Sensitivity	Specificity	Correctly Classified
Score 0	100%	0 %	15.1%
Score ≥ 1	97.3%	56.9%	63.0%
Score ≥ 2	82.7%	87.6.%	86.7%
Score ≥ 3	33.3%	98.3%	88.2%
Score 4	8.0%	99.1%	85.0%

ABC vs. McLaughlin vs. TASH

- ABC: ROC 0.90, 95% C.I. 0.86-0.93
- McLaughlin: ROC 0.80, 95% C.I. 0.75-0.85
- TASH: ROC 0.85, 95% C.I. 0.81-0.90

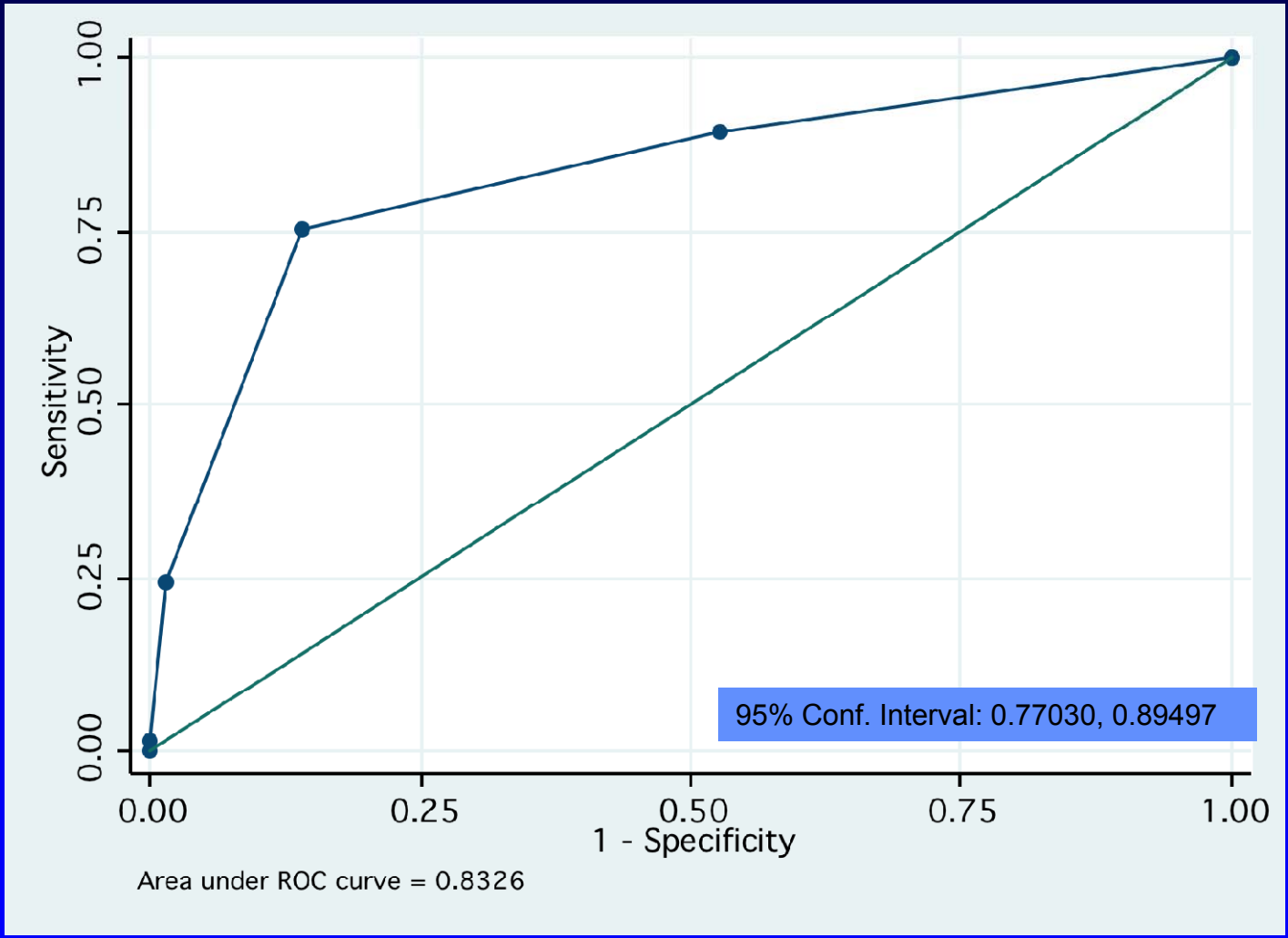
ABC Score-JHH



ABC Score-JHH

Cut-point	Sensitivity	Specificity	Correctly Classified
Score 0	100%	0 %	15.0%
Score ≥ 1	100%	30.9%	63.0%
Score ≥ 2	90.0%	67.3%	86.9%
Score ≥ 3	60.0%	95.6%	88.5%
Score 4	25.0%	100%	85.6%

ABC Score-UTSW



ABC Score-UTSW

Cut-point	Sensitivity	Specificity	Correctly Classified
Score 0	100%	0 %	15.3%
Score ≥ 1	89.5%	47.3%	53.8%
Score ≥ 2	75.6%	86.0%	84.4%
Score ≥ 3	25.6%	98.7%	87.5%
Score 4	25.0%	100%	85.6%

Logistic regression for MT

- Heart rate ≥ 120: O.R. 5.4, C.I. 3.36- 8.56
- (+) FAST: O.R. 18.3 , C.I. 11.39-29.39
- Systolic BP <90 : O.R. 5.0, C.I. 3.15-7.97
- Penetrating mech. : O.R. 2.3, C.I. 1.45-3.77

Comparison of AUROC

group	Obs	ROC Area	Std. Err.	Asymptotic Normal [95% Conf.	Interval]
1	495	0.9031	0.0173	0.86912	0.93704
2	93	0.8941	0.0441	0.80761	0.98054
3	372	0.8326	0.0318	0.77030	0.89497

Ho: area(1) = area(2) = area(3)
chi2(2) = 3.81 Prob>chi2 = 0.1491

Massive transfusion by 6 hours?

Cutpoint	Sensitivity	Specificity	Correctly Classified	LR+	LR-
(>= 0)	100.00%	0.00%	12.18%	1.0000	
(>= 1)	98.59%	50.39%	56.26%	1.9874	0.0280
(>= 2)	87.32%	81.64%	82.33%	4.7564	0.1553
(>= 3)	46.48%	96.68%	90.57%	13.9983	0.5536
(>= 4)	15.49%	99.41%	89.19%	26.4413	0.8501
(> 4)	0.00%	100.00%	87.82%		1.0000

Obs	ROC Area	Std. Err.	—Asymptotic Normal— [95% Conf.	Interval]
583	0.9004	0.0167	0.86770	0.93308

Conclusion

- MT protocols associated with improved survival
- Early protocol implementation, higher survival
- Most centers rely on clinical judgment alone
- Ability to assign objective data may improve the uniformity of protocol activation

Conclusion

- ABC score is easy to use and remember
- ABC score requires no lab testing, utilizing only data available during the primary
- ABC score is valid across different patient populations and trauma centers

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