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The National Trauma Data Bank story for emergency department thoracotomy: How old is too old?

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ABSTRACT

Background. The fastest growing segment of the American population is the elderly (>65 years). This change in demographics also is being seen in trauma centers. Emergency department thoracotomy is utilized in an attempt to restore circulation for patients arriving in extremis. The purpose of this study was to investigate the relationship between clinical variables, particularly age, and outcomes for injured patients receiving an emergency department thoracotomy.

Methods. Using the National Trauma Data Bank for years 2008–2012, observations with International Classification of Diseases, Ninth Revision, Clinical Modification procedure codes for exploratory thoracotomy were identified. Emergency department thoracotomy was defined as any observation that occurred at a time to thoracotomy less than the total time spent in the emergency department thoracotomy, and within 15 minutes of arrival. Mechanisms of injury, demographic data, and injuries were analyzed for predictors of survival and mortality rates. Mortality rates were determined for each decade and year of life.

Results. There were 11,380 observations for thoracotomy identified. Of these, 2,519 were emergency department thoracotomy, with the majority ($n = 2{,}026$, 80% observations) performed for penetrating wounds. Mortality rates ranged from 80% to 100% for each decade of life. Mortality was 100% for patients >57 years old with either penetrating or blunt mechanisms of injury.

Conclusion. Emergency department thoracotomy offered no survival benefit for patients older than 57 years of age. These data suggest that emergency department thoracotomy performed in elderly patients may be futile.

Fifty years ago, Beall et al described the use of emergency department thoracotomy (EDT) for resuscitation of the moribund patient presenting with penetrating cardiac wounds.[1] In the late 1970s, the concept was expanded to blunt trauma patients with reportedly high salvage rates.[2] Despite these studies demonstrating restoration of spontaneous circulation after circulatory arrest, many surgeons thought clinical criteria were needed for selecting patients who would benefit from EDT rather than a liberal use of the procedure, which had inherent risk associated with it. During the past 3 decades, several groups have attempted to elucidate clinical guidelines for EDT.[3] Previously identified predictors of survival included mechanism of injury, anatomic location of injury, injury severity, prehospital time, cardiopulmonary resuscitation (CPR), vital signs, cardiac rhythm, Glasgow Coma Scale (GCS) score, and signs of life.[3-20] This led to the development of guidelines that have somewhat helped to shape the decision-making for selective use of EDT.[4,18,21] Guidelines developed by the American College of Surgeons-Committee on Trauma, the Eastern Association for the Surgery of Trauma (EAST), and the Western Trauma Association (WTA) all utilize mechanism of injury, signs of life, CPR, and vital signs as clinically relevant factors in the decision-making process for whether to perform an EDT.[4,18,21] Using these guidelines, the majority of single institution studies demonstrate a low survival rate for EDT in patients typically in their third to fifth decade of life. Survivors older than this are rare.

For the past 2 decades, geriatric citizens defined as ≥65 years old have been the most rapidly growing segment of the American population. Additionally, these elderly individuals live very active, independent lives. Not surprisingly, trauma is the fifth most common

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cause of death in this segment of the population with falls and motor vehicle collisions accounting for >95% of the injuries.[22] These patients are challenging to care for due to the deteriorization in organ function as a result of aging. They also may have several comorbidities. Survival is impacted markedly by these derangements in physiologic reserve.

During this same time, there have been improvements in access to trauma centers. First, there has been a proliferation of new state trauma systems and a maturation of the older established systems. Simultaneously with these changes, prehospital care also has seen many advances that have been beneficial for injured patients. These changes have improved access for elderly injured patients to be cared for at a trauma center. Thus, the trauma surgeon is seeing an increase in geriatric patients presenting to the emergency department in extremis and must interpret mechanistic, physiologic, and clinical data within minutes to identify which of these elderly patients might benefit from an EDT. To date, none of the guidelines has included age as a variable for decision-making.

The purpose of this study was to evaluate the relationship between clinical variables, particularly age, and outcomes for patients receiving an EDT using the National Trauma Data Bank (NTDB).

Methods

Data source

The dataset of the American College of Surgeons (ACS) NTDB for the years 2008–2012 was used for this study. NTDB data are collected from a total of 805 hospitals across all 50 states in the United States that are verified by the American College of Surgeons-Committee on Trauma (ACS-COT). These hospitals include 235 Level I centers and 267 Level II centers; the remainder are either Level III, Level IV, or pediatric-only centers. The NTDB provides deidentified, protected trauma registry data that abide by an exact national trauma registry standard consisting of specific patient inclusion criteria and a uniform set of variables with associated variable definitions. All observations submitted to the NTDB go through a series of edit checks to ensure that the database is both accurate and reliable, and each year, the ACS-COT revises the dictionary of the National Trauma Data Standard data based on suggestions from NTDB participants, researchers, and committee members.[23] All records contained in the NTDB are deidentified as to patient and trauma center identity. Therefore, this study was exempt from the need for approval by the Institutional Review Board.

Patient inclusion

Records for this study were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code for “exploratory thoracotomy” (34.02). Of these observations, we defined a thoracotomy performed in the emergency department as any record with a procedure code time being performed in less than or equal to 15 minutes and time to procedure less than the total time spent in the emergency department. Records also were stratified by penetrating and blunt mechanism of injury using the data field for the mechanism of injury (injury type = 1, blunt; injury type = 2 penetrating). All other mechanisms of injury codes and those with missing data for age were excluded to yield the final study population.

Analytic approach

In terms of baseline characteristics, demographic variables such as age, sex, race, and payer status, as well as preexisting comorbidities and mechanism of injury were utilized to better characterize the patient population who undergo EDT and analyze patient-level factors that are potentially influencing the decision to perform an EDT. Prehospital vital signs and vital signs on arrival to ED also were analyzed to assess the utility of existing guidelines that recommend the use of these variables as indicators to select patients for an EDT. Finally, all-comer, unadjusted mortality, as well as hospital and intensive care unit (ICU) length of stays (LOS) and ventilator days for survivors were analyzed to investigate baseline patient outcomes and assess the success rate of EDTs in the study population. Overall descriptive statistics are reported with arithmetic means (standard deviation) or frequencies (proportions). *T* tests or χ^2 tests were used for parametric univariate statistical testing for comparisons between groups.

Age was the primary exposure variable with observations stratified by decade (<10 years, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80–89). Survival was the primary outcome of interest. Mortality and survival rates were calculated for each age group for both blunt and penetrating mechanism of injury. To achieve a more granular view of survival and mortality as a function of age, we calculated mortality and survival rates for each single year of age.

Statistical analyses were performed in STATA MP Version 14 (64-bit).

Results

For the years 2008–2012, a total of 3,659,548 records were submitted to the NTDB. Of these, 11,380 (0.3%) patients underwent thoracotomy, and of these patients, 2,585 (0.001%) met our definition for an EDT. Exclusion of observations that had missing data for age or those who did not have blunt or penetrating mechanisms of injury recorded yielded a final study population of 2,519 patients. Baseline characteristics of patients undergoing EDT demonstrated that the majority of patients were male (87.5%), of a minority race (67.1%), and self-pay (57.9%). The average age of 32 years old was consistent with other reports. Furthermore, the majority (80.4%) of patients who underwent EDT were injured by a penetrating wound, whereas 19.6% were injured by blunt forces. Not surprisingly, patients with blunt injuries were older and had more comorbidities than the penetrating group. Overall, the study population had low rates of preexisting comorbidities, with hypertension, smoking, and diabetes mellitus having the greatest prevalence (Table 1). These low rates for the co-morbidities most likely reflect underreporting by the trauma centers due to the inability of the health care providers to obtain this information from the family and patient in these patients. The overall survival rate for this study was 7.2%. When considering the mechanism of injury, the survival for blunt patients undergoing an EDT was 5.1%, whereas the survival rate for the penetrating group was 7.7%.

Collectively, the prehospital vital signs for the patients receiving an EDT were consistent with patients presenting in extremis with impending cardiac arrest (Table 2). Comparing the group by blunt versus penetrating injury revealed that those with a penetrating mechanism had a significantly lower systolic blood pressure, lower pulse rate, lower respiratory rate, and lower oxygen saturation, whereas there was no difference in the GCS scores (Table 2). Although these differences in vital signs may not influence clinical decision-making, the vital signs for the patients with penetrating wounds were bradycardia with agonal respirations representing a moribund patient when compared to the blunt mechanism group.

Comparison of admission vital signs by the mechanism of injury revealed similar trends as seen with the prehospital vital signs. The group with penetrating wounds had a significantly lower systolic blood pressure, lower pulse rate, and lower oxygen saturation. The admitting GCS score was similar for both mechanisms of injury (Table 3). Despite this statistical difference, the vital signs for both groups reflected profound shock, bradycardia, and impending apnea with hypothermia; the differences most likely do not have clinical

Table 1
Baseline patient characteristics.

Patient factors	Total EDT (n = 2,519)	Blunt (n = 493, 19.6%)	Penetrating (n = 2,026, 80.4%)	*P* value
Age (mean y)	32.4	39.9	30.6	<.001
Female (%)	12.5	26.2	9.1	<.001
Race (%)				<.001
White	32.1	65.2	24.2	
Black or African American	48.9	12.1	57.8	
Asian	1.3	3.2	0.8	
Other	17.7	19.5	17.2	
Pay status (%)				<.001
Medicare	3.3	7.6	2.5	
Medicaid	12.3	9.8	12.9	
Private	12.3	29.7	9.3	
Self-pay	57.9	32.8	63.0	
Blue Cross/Blue Shield	3.0	8.4	1.9	
Other government	7.8	7.0	8.0	
Other	2.9	4.8	2.5	
Comorbidities (%)				
Current smoker	1.2	0.8	1.3	.35
Diabetes mellitus	0.9	2.4	0.5	<.001
Hypertension requiring medication	1.5	4.3	0.9	<.001
Other	6.4	10.1	5.4	<.001
Survival (n, %)	180 (7.2%)	25 (5.1%)	155 (7.7%)	.05

relevance. Not surprisingly, the average injury severity score for the EDT group reflected severe injuries (mean = 33). The average LOS in the ED was brief after the decision was made to perform an EDT (mean = 31 minutes). In terms of disposition from the ED, those with penetrating mechanisms of injury were more likely to die in the ED, less likely to be transferred to the operating room, and less likely to be admitted to the ICU (data not shown).

The overall mortality rate for EDT was 92.9% (n = 2,339). Two-thirds of the patients failed to respond to the EDT and expired in the emergency department (n = 1,536, 65.6%). Not surprisingly, the majority of the patients (91.8%, n = 902) who had restoration of circulation after EDT were transferred to the operating room. Of the patients who responded to an EDT, 81.7% died (n = 803) during the hospitalization. A total of 180 patients (7.2%) survived to hospital discharge. The average hospitalization LOS for survivors was 21.6 days with the average ICU LOS being 15.5 days. The average duration of mechanical ventilation was 9.9 days. Although the ICU and hospital LOS were not significantly different by mechanism, they were less for the patients with penetrating wounds by 6 and 8 days, respectively (Table 4).

Stratification of observations into decades of life revealed that the majority of EDTs are performed on patients in their third decade of life, (n = 963, 38%). When looking at the extremes of age, the survival rate for children under the age of 10 years was 20% (n = 20). In contrast, there was only one survivor of an EDT in patients >60 years old (n = 151, 0.6%). When comparing survivors by the mechanism of injury and decade of age, the mortality rate ranged from 80% to 100% for blunt injuries and 91.2% to 100% for penetrating

Table 2
EMS vital signs in patients undergoing EDT for blunt versus penetrating injuries.

Prehospital vital signs mean (SD)	Overall (n = 2,519)	Blunt (n = 493)	Penetrating (n = 2,026)	*P* value
Systolic blood pressure (mm Hg)	43.7 (55.5)	65.6 (58.9)	37.7 (52.9)	<.001
Pulse (bpm)	56.6 (54.6)	77.2 (52.6)	50.8 (53.8)	<.001
Respiratory rate (respirations/min)	8.4 (11.2)	11.2 (11.7)	7.6 (11.0)	<.001
Oxygen saturation (%)	52.4 (43.8)	73.6 (34.5)	46.1 (44.3)	<.001
GCS total	5.3 (4.1)	5.4 (4.1)	5.3 (4.1)	.75

EDT, Emergency Department Thoracotomy; *GCS*, Galagow Coma Score.

Table 3
ED vital signs in patients undergoing EDT for blunt versus penetrating injuries.

ED vital signs mean (SD)	Overall (n = 2,519)	Blunt (n = 493)	Penetrating (n = 2,026)	*P* value
Systolic blood pressure (mm Hg)	28.8 (51.5)	38.5 (56.5)	26.4 (49.9)	<.001
Pulse (bpm)	30.8 (48.9)	43.7 (55.6)	27.5 (46.5)	<.001
Respiratory rate (respirations/min)	4.3 (10.0)	4.9 (9.0)	4.1 (10.2)	.17
Oxygen saturation (%)	46.0 (46.5)	61.4 (44.4)	41.8 (46.2)	<.001
Supplemental oxygen (%)	88.2	92.7	86.9	.003
Temperature (°C)	32.8 (9.4)	32.5 (10.1)	32.9 (9.2)	.71
GCS total	3.7 (2.4)	3.5 (2.1)	3.7 (2.5)	.20
ISS	33.2 (23.1)	33.8 (19.7)	33.1 (23.8)	.55
Total ED min	30.6 (118.9)	36.1 (82.1)	29.3 (126.3)	.26

ISS, injury severity score.

Table 4
Outcomes variables in patients undergoing EDT for blunt versus penetrating injuries.

Outcome variables mean (SD)	Overall (n = 2,519)	Blunt (n = 493)	Penetrating (n = 2,026)	*P* value
Died (%)	92.9	94.9	92.3	.05
Outcome variables of survivors				
Length of stay (d)*	21.6 (21.8)	28.1 (23.1)	20.6 (21.5)	.11
ICU days*	15.5 (14.3)	20.2 (12.7)	14.7 (14.5)	.09
Vent days*	9.9 (10.5)	11.4 (9.8)	9.6 (10.7)	.44

* Of survivors (overall n = 180, blunt n = 25, penetrating n = 155).

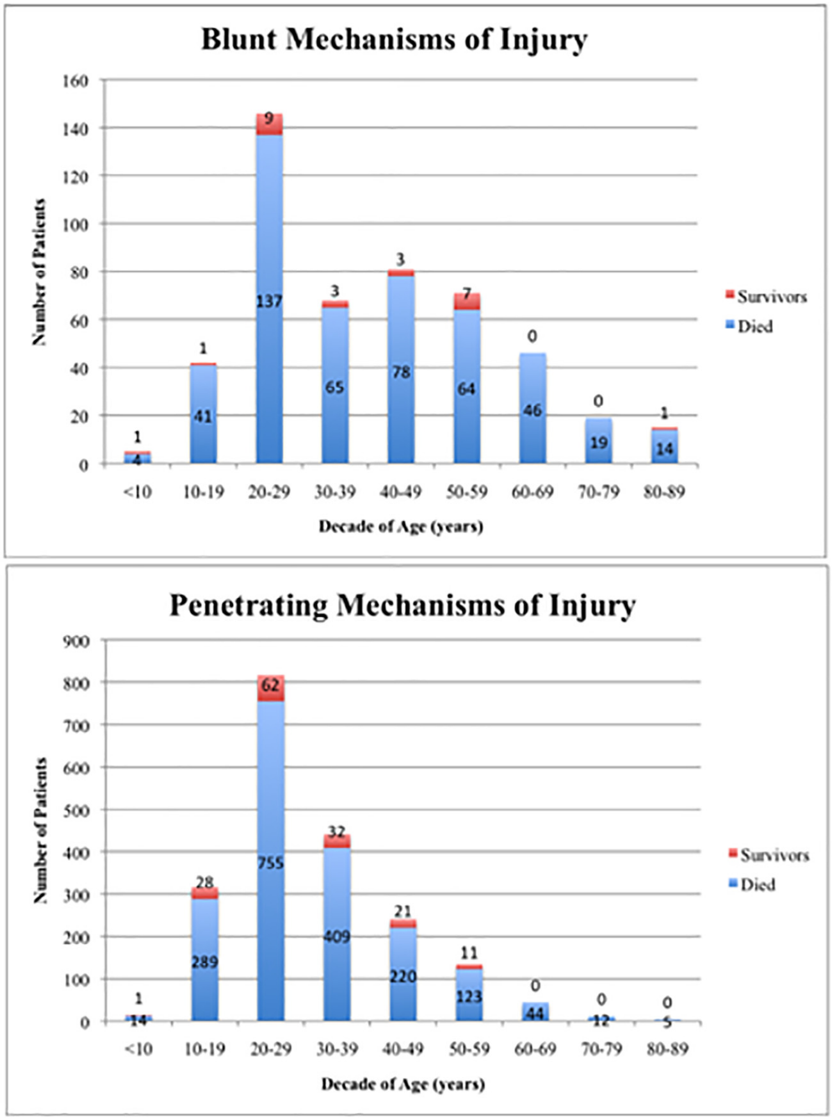

Fig. 1. Mortality and survival by age group in blunt and penetrating traumas.

injuries (Fig 1). In effort to further refine the relationship between age and mortality after EDT, the data were analyzed for each successive year of life. There was only one survivor of the patients ≥57 years (Fig 2).

Discussion

The selection criteria for patients who may benefit from EDT has been the subject of debate since EDT was first described 50 years ago. One area of controversy is the reliability of prehospital vital signs and signs of life as criteria for selection of patients. The NTDB is the only database that captures patient outcomes from ACS-verified, Level I and II trauma centers. It includes vital signs from the prehospital setting and on arrival to the ED. Thus, this is the first study that evaluates these variables with outcomes. It is also the first study that includes both pediatric and adult patients. These data support the use of ED vital signs in the selection of patients who may benefit from EDT. The observation that the mortality rate for patients over the age of 57 was essentially 100%, however, suggests that the present criteria lack specificity for this patient population.

The overall mortality rate in this study was consistent with prior studies. The mortality rate for patients presenting in extremis after blunt injury is one of the lowest in the literature. This low mortality rate may be due to the strict selection criteria used in this study, which would eliminate patients with blunt traumatic arrest undergoing EDT >15 minutes after arrival. The mortality rate for the children <11 years old was 80%. Although the number of patients was small ($n = 20$), there was one survivor for both blunt and penetrating mechanisms of injury.

In contrast to the pediatric population, the mortality rate in this study for older patients over the age of 57 years was 99.4%. The selection criteria used for EDT of this sole survivor who was injured by blunt force and 80 years old are unknown. Eliminating this single survivor would result in a mortality rate of 100% for the older patients. There are several potential explanations for this finding. The function of all organs declines with aging resulting in limited physiologic reserve. Thus, the ability of the patient to have restoration of spontaneous circulation after EDT is inherently much less when compared to younger patients presenting with impending cardiac arrest. Comorbidities, such as coronary artery disease, hypertension, and diabetes mellitus, also impact organ function. The incidence of

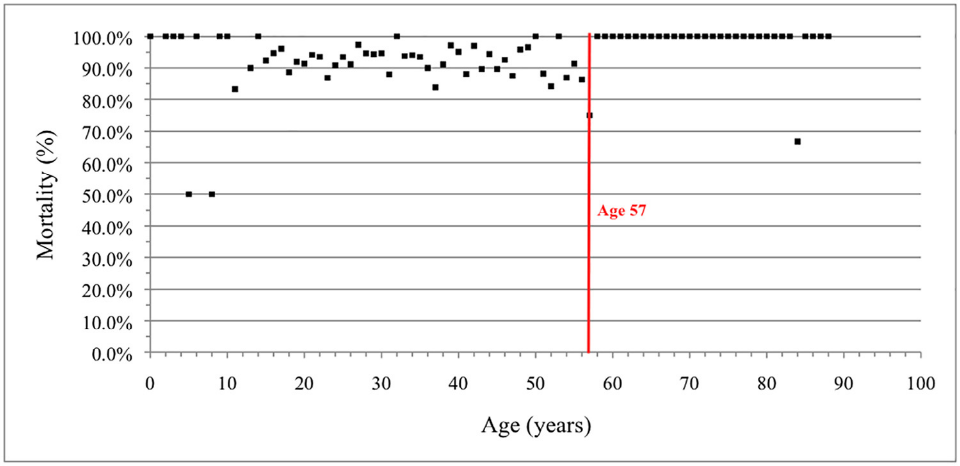

Fig. 2. Mortality as a function of age.

comorbidities reported to the NTDB is much less than the incidence in the general population. This ostensible difference is most likely explained by underreporting which could be explained by the inability of the trauma staff to obtain an accurate medical history in this patient population. Lastly, as in the pediatric population, the lack of survivors in the older patients suggest the current criteria utilized for selecting patients for EDT effective in patients aged 15 to 50 lack sensitivity for patients over the age of 57, which suggests that as in the pediatric population, the use of EDT should be discouraged without compelling evidence of a reversible cause of extremis.

Guidelines have been developed by the EAST,[18] the WTA,[4] and the ACS-COT[21] to assist trauma surgeons in the selection of patients for EDT. The EAST recommendations utilized mechanism of injury and absence of a pulse and signs of life when developing recommendations. The WTA algorithm begins with signs of life and the need for CPR. The ACS-COT recommend that EDT be performed rarely in patients sustaining cardiopulmonary arrest secondary to blunt trauma because of its very low survival rate and poor neurologic outcomes, and suggest that EDT should be limited to those who arrive with vital signs at the trauma center and experience a witnessed cardiopulmonary arrest. Unfortunately, these guidelines were developed in 2000 and published in 2001, and they may not be applicable today. Our results suggest that younger patients presenting in extremis after blunt injury may benefit from EDT which is contrary to the EAST and ACS-COT guidelines. In contrast, older patients in this study who presented to the trauma center in extremis did not benefit from EDT. Our data for prehospital and ED vital signs in the patients with penetrating wounds support all 3 guidelines for early use of EDT.

As noted earlier, trauma surgeons must analyze many clinical and physiologic factors rapidly when deciding to perform an EDT. According to a recent survey of EAST members conducted by Dennis et al, there is great variability in what specific factors trauma surgeons utilize in their practice.[6] Only 38.5% of respondents indicated that they consider patient age when deciding to perform an EDT. Regarding other patient specific factors, 55.7% of respondents indicated that they consider comorbidities. These findings along with the results from our study regarding the lack of survivors in the older patients using the prehospital and ED vital signs support our recommendation that additional variables such as age and less so comorbidities are needed to assist the trauma surgeon when deciding which elderly patient may benefit from EDT. The discrepancies and gaps in existing literature make it difficult for trauma surgeons to practice evidence-based medicine; indeed, variations in practice pattern suggest that little consensus remains on the role of age and comorbidities as appropriate indications and contraindications for EDT.

The findings of this study must be viewed in the context of its limitations. Some limitations are inherent to the use of large datasets. For example, the patient population was defined utilizing ICD-9-CM procedure codes, which has potential variability and error in coding.[23] In addition, observations were defined as an EDT if the procedure occurred within 15 minutes of arrival to the ED. This criterion may have underestimated the number of ED thoracotomies due to the overlooking of patients who received a thoracotomy in the ED more than 15 minutes after arrival; however, we think most EDTs in patients in extremis occur during that 15-minute time period. Because a majority of our patients had penetrating injury, we decided on a 15-minute limit to ensure we were truly capturing our desired patient population.

Despite these limitations, this study identifies a specific age threshold at which mortality reaches 100% in trauma patients using a large study population. Because an EDT holds inherently a high risk-to-benefit ratio, more work is needed to integrate this finding with other patient and hospital level factors to better predict who should and should not receive emergency thoracotomies. A recent study investigating penetrating cardiac injuries in NTDB developed a predictive model for outcomes with a predictive power of 93% that was more robust than its previous counterparts.[24] Advances in machine learning, predictive analytics, and increased standardization of large databases such as the NTDB will allow us to better utilize evidence-based medicine for critical decision-making and improved patient outcomes.

In conclusion, EDT as currently practiced in American trauma centers carries a high mortality rate and low survival rate despite several guidelines from professional organizations. Vital signs in the prehospital setting and on arrival in the emergency department are effective for identifying young patients (<57 years of age) who might benefit from EDT. In contrast, patients >57 years old who undergo EDT do not survive. The present algorithms and protocols lack sensitivity for identifying elderly patients who might survive after EDT.

References

1. Beall AC, Diethrich EB, Cooley DA, DeBakey ME. Surgical management of penetrating cardiovascular trauma. South Med J 1967;60:698-704.

2. Baker CC, Thomas AN, Trunkey DD. The role of emergency room thoracotomy in trauma. J Trauma 1980;20:848-55.
3. Powell DW, Moore EE, Cothren C, et al. Is emergency department resuscitative thoracotomy futile care for the critically injured patient requiring prehospital cardiopulmonary resuscitation? J Am Coll Surg 2004;299:211-5.
4. Burlew CC, Moore EE, Moore FA, et al. Western trauma association critical decisions in trauma. J Trauma Acute Care Surg 2012;73:1359-63.
5. Capote A, Michael A, Almodovar J, Chan P, Skinner R, Martin M. Emergency department thoracotomy: too little, too much, or too late? Am Surg 2013;79:982-6.
6. Dennis BM, Medvecz AJ, Gunter OL, Guillamondegui OD. Survey of trauma surgeon practice of emergency department thoracotomy. Am J Surg 2016;212:440-5.
7. Edens JW, Beekley AC, Chung KK, et al. Longterm outcomes after combat casualty emergency department thoracotomy. J Am Coll Surg 2009;209:188-97.
8. Fairfax LM, Hsee L, Civil ID. Resuscitative thoracotomy in penetrating trauma. World J Surg 2015;39:1343-51.
9. Hwabejire JO, Nembhard CE, Oyetunji TA, et al. Age-related mortality in blunt traumatic hemorrhagic shock: the killers and the life savers. J Surg Res 2017;213:199-206.
10. Kavolius J, Golocovsky M, Champion HR. Predictors of outcome in patients who have sustained trauma and who undergo emergency thoracotomy. Arch Surg 1993;128:1158-62.
11. Miglietta MA, Robb TB, Eachempati SR, et al. Current opinion regarding indications for emergency department thoracotomy. J Trauma 2001;51:670-6.
12. Mollberg NM, Glenn C, John J, et al. Appropriate use of emergency department thoracotomy: implications for the thoracic surgeon. Ann Thorac Surg 2011;92:455-61.
13. Moore EE, Knudson MM, Burlew CC, et al. Defining the limits of resuscitative emergency department thoracotomy: a contemporary western trauma association perspective. J Trauma 2011;70:334-9.
14. Moore HB, Moore EE, Burlew CC, et al. Establishing benchmarks for resuscitation of traumatic circulatory arrest: success-to-rescue and survival among 1,708 patients. J Am Coll Surg 2016;223:42-50.
15. Rhee PM, Acosta J, Bridgeman A, Wang D, Jordan M, Rich N. Survival after emergency department thoracotomy: review of published data from the past 25 years. J Am Coll Surg 2000;190:288-98.
16. Seamon MJ, Chovanes J, Fox N, et al. The use of emergency department thoracotomy for traumatic cardiopulmonary arrest. Injury 2012;43:1355-61.
17. Seamon MJ, Fisher CA, Gaughan JP, Kulp H, Dempsey DT, Goldberg AJ. Emergency department thoracotomy: survival of the least expected. World J Surg 2008;32:602-12.
18. Seamon MJ, Haut ER, Van Arendonk K, et al. An evidence-based approach to patient selection for emergency department thoracotomy. J Trauma Acute Care Surg 2015;79:159-73.
19. Seamon MJ, Shiroff AM, Franco M, et al. Emergency department thoracotomy for penetrating injuries of the heart and great vessels: an appraisal of 283 consecutive cases from two urban trauma centers. J Trauma 2009;67:1250-8.
20. Slessor D, Hunter S. To be blunt: are we wasting our time? Emergency department thoracotomy following blunt trauma: a systematic review and meta-analysis. Ann Emerg Med 2015;65:297-307, e16.
21. Working Group, Ad Hoc Subcommittee on Outcomes, American College of Surgeons-Committee on Trauma. Practice management guidelines for emergency department thoracotomy. J Am Coll Surg 2001;193:303-9.
22. Yelon JA, Luchette FA. Geriatric Trauma and Critical Care. 1st ed. New York: Springer-Verlag; 2014:390.
23. National Trauma Data Bank. National trauma data standard data dictionary 2011 admissions. 2011.
24. Asensio JA, Ogun OA, Petrone P, et al. Penetrating cardiac injuries: predictive model for outcomes based on 2016 patients from the national trauma data bank. Eur J Trauma Emerg Surg 2017;1-7.

Discussion

Dr Salman Ahmad (Columbia, Missouri): Much is already known, as you mentioned about the indications for ED thoracotomies. As you mentioned, timing has always been the secret sauce of ED thoracotomy survival. My understanding is that the NTDB data includes seen time and transport time, as well as time of vital sign loss. Would you consider these variables in your analysis? And how do you suppose they would affect the window of opportunity for older patients versus younger patients?

My second questions is, does the NTDB designation of penetrating versus blunt actually specify where the penetrating injury is, whether it's thoracic, cardiac box, abdomen and whether there's a direct influence on outcome in that case?

Third, the significance of your variables such as race or payer status are always troubling but it's nothing new to the trauma research. Could they represent convoluted variables that are not accounted for in the retrospective study? And could there be other variables that, in fact, for someone who's older, you might want to consider before deciding to do the ED thoracotomy or not.

Number 4, along the same lines, have you correlated comorbidities with age, where older patients with more comorbidities were likely to die versus others?

And, finally, could your statistical analyses suffer from selection bias due to the number of ED thoracotomies performed for blunt trauma? In other words, perhaps the culture of limited intervention for this mechanism, blunt trauma, is already baked into the database. So, in fact, if you were to just limit your analysis to penetrating trauma, would you arrive at similar or perhaps more nuanced conclusions?

Ms Lindsay Gil: In regards to your comments on prehospital variables, you make an excellent point. The NTDB does include variables such as EMS response time and seen time, however, it does not include a variable for time of vital sign loss. I'm sure these timings do have an effect on survival, and our group is actually currently working on an extensive analysis of prehospital care timing.

In regards to your point concerning anatomical location of injury, the NTDB does not include the specific injury sites in their raw data; however, it is possible to obtain injury sites from the Barell Injury Diagnosis Matrix, which correlates specific ICD–9 codes to specific locations of injury. However, our main goal of this study was to focus on patient age and its association with mortality.

Your thoughts related to certain variables in the data set representing a larger picture prehospital setting are very interesting. We were not surprised by the finding that the majority of patients were uninsured or self-pay. It was in some ways expected since many trauma centers, when registering patients in extremis, are not able to establish the patient's insurance status. The variables portraying patient demographics may suggest variability in prehospital settings, such as seen time and transport time, and we recognize that these variables may influence survival and mortality rates. However, we also thought that trauma surgeons practicing at any of the trauma centers are knowledgeable regarding the published guidelines and recommendations for selecting patients that might benefit from an ED thoracotomy. So, we did not feel the inclusion of all the transport data would influence the outcome of mortality that we studied.

In regards to your point concerning comorbidities, we have not correlated comorbidities to age, but I'm sure we would find a greater number of comorbidities in the older population. However, in our investigation, the most common comorbidity was hypertension, and it consisted only of 1.5% of our population.

Additionally, excluding ages greater than 58 and less than 10 still shows a 92.4% mortality rate suggesting that regardless of these comorbidities, mortality rates are still high and there's a need for better selection criteria regarding the use of ED thoracotomy.

And, finally, your point involving the culture of limited intervention for blunt injuries was an excellent one. The guidelines that recommend against ED thoracotomy for blunt injuries have been utilized by practicing trauma surgeons for many years. However, despite the use of established practice guidelines, the mortality rates were still 100% for ages above 58 and below 10 regardless of mechanism of injury.

Dr Charles Lucas (Detroit, Michigan): Remind me the next time I come to Chicago to dye my hair dark black. Doing an emergency department thoracotomy in our place is like working in a zoo. How far is it to our operating room and how many minutes does it take you to get the patient to the operating room?

Ms. Lindsay Gil: That's a very interesting question. That was actually one of the first things I noticed as a medical student when I started shadowing was that our emergency department and our operating rooms are quite far apart. They're, in fact, kind of across the hospital and on different floors. And this is in contrast to Shock Trauma Center in Baltimore where the ORs are very close. I'm not exactly sure about the exact distance or the timing, but I'm sure this does have an effect on patients' outcomes.

Dr Frederick Luchette (Maywood, Illinois): Charlie, when you come to Chicago, make sure it's purple, because many people our age dye their hair black, so we won't be able to distinguish whether you're young or old.

I can tell you in our institution, and my colleagues are sitting right here, if we're running down the hall and somebody has got the elevator, we can be in the ED or in the OR within 5 minutes of the patient arriving.