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Resuscitative thoracotomy for pediatric trauma in Illinois, 1999 to 2009



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Abstract

BACKGROUND: Outcomes in adults who undergo resuscitative thoracotomy are poor. Few studies have examined the procedure's use in pediatric trauma.

METHODS: The Illinois State Trauma Registry was queried for thoracotomy performed in the emergency department from 1999 to 2009, for patients aged 0 to 15. Injury mechanism, vital signs, and mortality were examined while controlling for injury severity.

RESULTS: Resuscitative thoracotomy was infrequently performed in pediatric trauma (n = 25; 2.3/year). Most patients had suffered penetrating injury. Patients who underwent resuscitative thoracotomy were in extremis, with only 17% demonstrating signs of life upon presentation. Although 6 patients (24%) survived initially, only 2 (8%) survived to hospital discharge.

CONCLUSIONS: Resuscitative thoracotomy was rarely performed in children in Illinois emergency departments. Survival is low for thoracotomy in the emergency department, but some patients who presented with penetrating injuries did have positive outcomes, supporting a continued role for the procedure in select cases.

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Resuscitative thoracotomy in the emergency department (ED) can be life-saving for patients in extremis, particularly those who have suffered penetrating cardiac injuries.

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Outcomes in adult patients who undergo thoracotomy in the ED are generally poor, and most trauma surgery guidelines recommend its use only in a limited set of cases.¹ Few studies have looked at the procedure's use in the pediatric trauma population.^{2,3} Pediatric trauma patients present less frequently with severe penetrating injury and predictors of trauma mortality in adults may poorly predict pediatric mortality.⁴

As resuscitative thoracotomy gained acceptance in pediatric trauma centers throughout the 1980s and 1990s, early research showed that the procedure was used in patients presenting in extremis irrespective of injury mechanism. Outcomes were universally poor, especially among patients who had suffered blunt trauma: overall

Table 1 Characteristics of pediatric trauma patients undergoing resuscitative thoracotomy

	Resuscitative thoracotomy (n = 25*)	No resuscitative thoracotomy (n = 62,894*)	P value
Age, mean (SD)	13 (2.8)	7.3 (5.0)	<.001
Male sex, n (%)	19 (76)	40,429 (64)	.60
Blunt mechanism, n (%)	6 (24)	51,572 (91)	<.001
ED SBP 0, n (%)	20 (83)	737 (1.4)	<.001
ED GCS 3, n (%)	24 (96)	1,687 (3.2)	<.001
Injury severity score, mean (SD)	35 (28)	5.9 (6.6)	<.001

ED = emergency department; GCS = Glasgow Coma Scale; SBP = systolic blood pressure; SD = standard deviation.

*Because of missing data, percentages are calculated from smaller n for some categories.

survival was less than 5% in several studies and approached 0% for blunt injuries.⁵⁻⁷ However, 2 recent studies have shown a possible improvement in mortality, although neither is a large enough study of pediatric patients to convincingly show improvement.^{2,3} The current data are mixed with respect to resuscitative thoracotomy utilization in blunt pediatric trauma with most studies showing very poor or no survival after resuscitative thoracotomy for blunt trauma.⁸ A recent literature review found 30 pediatric patients who underwent resuscitative thoracotomy after blunt or penetrating injury, with no surviving patients reported.⁹ In general, small patient populations and single center experience confound most of these studies, resulting in poor generalizability to overall practice.^{2,3,8,9}

In general, resuscitative thoracotomy is controversial even in the adult population. The procedure is often described as futile for most patients presenting to the hospital in extremis.¹⁰ Performing resuscitative thoracotomy in the ED is associated with significant blood exposures for providers, as recent data demonstrate increased prevalence of blood-borne illnesses such as HIV and hepatitis B and C in today's trauma population.¹¹ Additionally, resuscitative thoracotomy is associated with excessively high healthcare costs. For example, resuscitative thoracotomy is associated with costs of more than \$100,000 per quality-adjusted life year gained in blunt trauma victims.¹² Additionally, a significant portion of those who do survive do so with significant neurologic impairment.¹

This study aims to determine the incidence of resuscitative thoracotomy in pediatric trauma patients as well as the patient characteristics associated with the procedure's use and survival. Resuscitative thoracotomy is performed rarely in pediatric trauma, necessitating a very large dataset to characterize the population. This study utilizes the Illinois State Trauma Registry resulting in more than 60,000 pediatric trauma cases for analysis.

Methods

The Illinois State Trauma Registry is maintained by the Illinois Department of Public Health as a record of all trauma admissions statewide to Level I or II trauma centers. Illinois Level I and II designation is determined based on trauma surgeon coverage, availability of specialists, and

participation in organizing the overall trauma system. Individual records within the database are deidentified with respect to patient and hospital identification. However, data regarding patient demographics, mechanism of injury, vital signs, procedures performed, and outcome are readily accessible. Because of the deidentified, retrospective nature of the data, an exemption was granted from the Institutional Review Board of Northwestern University.

The database was queried from 1999 to 2009 for all trauma patients aged 15 or younger, reflecting the group who are typically transported to pediatric hospitals if available.¹³ Relevant demographic, clinical, and procedural information was extracted from each patient record and combined into a unified dataset for the time period studied. Resuscitative thoracotomy procedures were determined by identifying patients who underwent exploratory thoracotomy (International Statistical Classification of Diseases, 9th edition [ICD-9] procedure code 34.02) and/or cardiac repair (ICD-9 procedure code 37.4) while in the ED. Procedures meeting these criteria were not included if they were performed in the operating room or elsewhere in the hospital.

Using R 2.15.0 (R Foundation for Statistical Computing, Vienna, Austria), we examined thoracotomy use and survival in terms of demographic characteristics, blunt vs penetrating injury mechanism, Injury Severity Score, and systolic blood pressure (SBP) and heart rate on ED arrival.¹⁴ Data were analyzed via chi-square analysis for categorical variables and with a Student *t* test for continuous variables. Because of the relatively small number of cases, multivariate analysis could not be performed. Frequency of resuscitative thoracotomy and survival were calculated and compared for adult and pediatric populations within the same state database. Mortality was determined at disposition from the ED and at hospital discharge.

Results

Resuscitative thoracotomy was infrequent in the pediatric trauma population (n = 25; 2.3/year), with the exception of older adolescents (57 patients aged 16 to 18 underwent ED thoracotomy during the study period). Resuscitative thoracotomy was used most frequently for penetrating trauma (n = 19, 76%) as compared with blunt trauma (n = 6, 24%), despite the fact that 91% of the pediatric trauma population

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