Survival after Emergency Department Thoracotomy: Review of Published Data from the Past 25 Years

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Background: Emergency department thoracotomy (EDT) has become standard therapy for patients who acutely arrest after injury. Patient selection is vitally important to achieve optimal outcomes without wasting valuable resources. The aim of this study was to determine the main factors that most influence survival after EDT.

Study Design: Twenty-four studies that included 4,620 cases from institutions that reported EDT for both blunt and penetrating trauma during the past 25 years were reviewed. The primary outcomes analyzed were in-hospital survival rates.

Results: EDT had an overall survival rate of 7.4%. Normal neurologic outcomes were noted in 92.4% of surviving patients. Factors reported as influencing outcomes were the mechanism of injury (MOI), location of major injury (LOMI), and signs of life (SOL). Survival rates for MOI were 8.8% for penetrating injuries and 1.4% for blunt injuries. When penetrating injuries were further separated, the survival rates were 16.8% for stab wounds and 4.3% for gunshot wounds. For the LOMI, survival rates were 10.7% for thoracic injuries, 4.5% for abdominal injuries, and 0.7% for multiple injuries. If the LOMI was the heart, the survival rate was the highest at 19.4%. The third factor influencing outcomes was SOL. If SOL were present on arrival at the hospital, survival rate was 11.5% in contrast to 2.6% if none were present. SOL present during transport resulted in a survival rate of 8.9%. Absence of SOL in the field yielded a survival rate of 1.2%. There was no clear single independent preoperative factor that could uniformly predict death.

Conclusions: The best survival results are seen in patients who undergo EDT for thoracic stab injuries and who arrive with SOL in the emergency department. All three factors—MOI, LOMI, and SOL—should be taken into account when deciding whether to perform EDT. Uniform reporting guidelines are needed to further elucidate the role of EDT taking into account the combination of MOI, LOMI, and SOL. (J Am Coll Surg 2000;190:288–298. © 2000 by the American College of Surgeons)

Advances made in prehospital systems have resulted in rapid transport of the severely injured.[1,2,3] Improved communications have also allowed receiving physicians to anticipate the needs of patients in distress. These and other advances in trauma care have made emergency department thoracotomy (EDT) a standard procedure. Although there is no doubt as to the usefulness of this procedure, the key is to identify those who will most likely benefit to avoid the high costs associated with this procedure. These costs include loss of the patient dignity, risk to care providers during the procedure, and the use of valuable health care resources.

Since the first recorded successful thoracotomy by Dr Rehn[4] more than 100 years ago for a dying patient stabbed in the heart, there have been many reports of EDT. This first reported procedure was not an EDT, because it was performed 4 days after the injury. Nevertheless, Dr Rehn reported that he was "forced" to perform a thoracotomy because the patient was going to die otherwise. Those who now care for the injured find themselves in similar situations.

EDT has gone through many evolutions.[5] After a period of widespread use for those suspected of having a cardiac injury, it lost favor as other alter-

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natives, such as closed chest compressions and pericardiocentisis,[6] were found to be useful. Like many aspects of medicine, the pendulum has swung back in favor of the EDT, which has now found a useful role in the modern care of the severely injured. This resurgence in the use of EDT was demonstrated by Dr Beall and others in treating patients with life-threatening cardiac injuries.[7-13] The concept of EDT was further supported by demonstrating that external cardiac compression in trauma was of limited value[14,15] and that temporarily occluding the thoracic aorta in patients with exsanguinating abdominal trauma was sometimes helpful.[16-18]

Current indications for EDT include cardiopulmonary arrest or extremis after injury that precludes transport to the operating room. Most reports are in agreement that the procedure should be performed in the following manner. The chest is rapidly opened by a left anterior lateral approach with minimal skin preparation, while simultaneously securing the airway and achieving vascular access. Once the chest is opened the procedure provides opportunity for: 1) control of hemorrhage; 2) pericardotomy to relieve tamponade and control of cardiac hemorrhage; 3) occlusion of the descending thoracic aorta to increase perfusion of the heart and brain and possibly decrease distal hemorrhage; 4) direct cardiac massage; and 5) control of air embolism.[19-25]

The method of reporting EDT outcomes has varied widely in the literature. Most reports retrospectively review EDTs; other studies report outcomes after the implementation of standardized protocols for patient selection. Some studies combine EDT with operating room thoracotomies, combining emergent and urgent procedures. Frequently reported variables in studies of EDT include mechanism of injury (MOI), location of major injury (LOMI), and signs of life (SOL). Most studies include one or two of these variables but rarely all three. Those studies reporting all three variables list them independently rather than in combination. This study was undertaken to compile the vast body of literature and to summarize the results of EDT after trauma. Based on the results, recommendations are provided to help the practitioner in determining which patients would benefit the most from this procedure.

METHODS

A Medline search for all publications dealing with emergency thoracotomies for the past 25 years was performed using the key words "thoracotomy" and "emergency." This resulted in 548 publications, the titles of which were reviewed to determine relevancy. Additional searches using key words "trauma," "resuscitation," "penetrating," "cardiac," and "humans" were also performed. Bibliographies of relevant publications were reviewed to identify reports that were not located by the Medline search. The following variables were extracted from articles reviewed: Survival to discharge, MOI, LOMI, and SOL. Neurologic outcomes for survivors were also extracted from the publications reporting this variable. Data from reports updating prior study results were not duplicated.[26-36] For the total survival rate, only studies that reported outcomes for both blunt and penetrating were used because some studies reported only results of EDT after penetrating injuries, penetrating cardiac injuries, or thoracic injuries. In these cases, the data were not used for overall EDT results, but instead for the cumulative data of a particular category. For example, reports on EDT for penetrating injuries were used to determine survival rates after penetrating injuries but not used for the overall survival rate. The majority of the publications describing outcomes after penetrating cardiac injuries did not address EDT. So, not all studies dealing exclusively with penetrating cardiac injuries were reviewed because of the scope of this analysis. One particular study reported outcomes from London, England. The data were not used because they reported only those patients who were transported by helicopter.[37] The categories of MOI, LOMI, or SOL used only data that could be extracted accurately.

Definitions

EDT was defined as a procedure that was emergent and performed in the emergency room or trauma resuscitation room shortly after presentation. Urgent thoracotomies performed in the operating room were not included in this analysis.[38,39] If a study included both EDT and operating room thoracotomy, only EDT data were extracted. Mechanism of injury was divided into blunt or penetrating. The penetrating trauma was subdivided as stabbing-type wound (knives or piercing instru-

Table 1. Survival Rates after Emergency Department Thoracotomy from Institutions Reporting Both Penetrating and Blunt Trauma

First author	Location	Journal	Year	Years in review	Total survivors*	EDTs performed	Survival rate (%)
Branney[45]	Denver	J Trauma	1998	23	41	950	4.3
Bleetman[50]	UK	Injury	1996	2.5	1	18	5.6
Brown[51]	Indiana	Am Surg	1996	7.5	4	160	2.5
Velmahos[52]	Johannesburg	Arch Surg	1995	12.5	43	846	5.1
Mazzorana[40]	Oakland	Am Surg	1994	6	10	273	3.7
Durham[53]	Houston	J Trauma	1992	6	32	387	8.3
Lorenz[54]	San Francisco	J Trauma	1992	10.5	40	424	9.4
Boyd[41]	Youngstown	J Trauma	1992	4	2	28	7.1
Esposito[48]	Seattle	J Trauma	1991	4	2	112	1.8
Ivatury[55]	Bronx	J Trauma	1991	6	17	163	10.4
Lewis[56]	Cape Town	Injury	1991	2	8	45	17.8
Ordog[57]	Los Angeles	J Emerg Med	1987	6	5	80	6.3
Feliciano[58]	Houston	Am J Surg	1986	7	25	333	7.5
Schwab[59]	Norfolk	Am Surg	1986	2	14	51	27.5
Brautigan[60]	Detroit	Am J Emerg Med	1985	2	4	32	12.5
Danne[43]	Washington, DC	J Trauma	1984	2	10	89	11.2
Vij[44]	Detroit	Surgery	1983	2	5	63	7.9
Shimazu[61]	Baltimore	J Trauma	1983	5	5	153	3.3
Flynn[42]	Houston	Ann Emerg Med	1982	1	4	33	12.1
Harnar[62]	Seattle	Am J Surg	1981	2	5	64	7.8
Baker[47]	San Francisco	J Trauma	1980	7	33	168	19.6
Oparah[63]	Los Angeles	J Thorac Cardiovasc	1979	5	2	14	14.3
MacDonald[64]	Long Beach	JACEP	1978	4.5	2	28	7.1
Mattox[65]	Houston	JACEP	1974	3	27	106	25.5
Total					341	4,620	7.4

*Total survivors were those that were alive at discharge from the hospital.
EDT, emergency department thoracotomy.

ment) or gunshot wound. Shotgun injuries were categorized as gunshot wounds. LOMI was subdivided as cardiac, thoracic, abdominal, or multiple. Data presented in the thoracic category included cardiac injuries. SOL were defined as the presence of one or several of the following: cardiac electrical activity, respiratory effort, and pupillary response. Because SOL were reported in various manners, we subdivided this category as SOL in the hospital or no SOL in the hospital. It was also categorized as no SOL in the field or SOL during transport. Normal neurologic outcomes were defined as functional status without any major sequelae or if the patient could be discharged to home with ability to perform activities of daily living. For this analysis, survival was defined as discharged alive from the hospital. Reviewed reports varied in the definition of survival, with survival being defined as survival from the procedure, survival from the operating room, or survival to ICU admission.

RESULTS

Review of the studies available showed 4,620 patients from 24 studies who underwent EDT for both blunt and penetrating injury. The overall survival rate was 7.4%. No clear trends were noted over time. The range of reported survival rates was 1.8% to 27.5%. (Table 1). Only studies that reported both blunt and penetrating trauma were included in this tabulation.

When the MOI was examined, the survival rates were 8.8% for penetrating injuries and 1.4% for blunt trauma. Further separation according to the type of penetrating injury demonstrated survival rates of 16.8% for stab wounds and 4.3% for gunshot wounds (Table 2).

Table 2. Survival Rates of Emergency Department Thoracotomy Based on Mechanism of Injury

				Stab wound			Gunshot wound			Penetrating			Blunt		
First author	Location	Journal	Year	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)
Branney[45]	Denver	J Trauma	1998	21	147	14.3	12	330	3.6	33	483	6.8	8	385	2.1
Brown[50]	Indiana	Am Surg	1996	4	38	10.5	0	111	0.0	4	149	2.7	0	11	0.0
Velmahos[51]	Johannesburg	Arch Surg	1995	26	312	8.3	16	358	4.5	42	670	6.3	1	176	0.6
Mazzorana[40]	Oakland	Am Surg	1994	6	52	11.5	4	200	2.0	10	252	4.0	0	21	0.0
Millham[66†]	Boston	J Trauma	1993							13	290	4.5			
Durham[53]	Houston	J Trauma	1992	17	112	15.2	15	206	7.3	32	318	10.1	0	69	0.0
Boyd[41]	Youngstown	J Trauma	1992	1	2	50.0	1	9	11.1	2	11	18.2	0	17	0.0
Esposito[48*]	Seattle	J Trauma	1991							1	24	4.2	1	88	1.1
Ivatury[55]	Bronx	J Trauma	1991	12	49	24.5	4	85	4.7	16	134	11.9	0	29	0.0
Lewis[56*]	Cape Town	Injury	1991							8	32	25.0	0	13	
Ivatury[67†]	Bronx	J Trauma	1987	8	49	16.3	2	51	3.9	10	100	10.0			
Ordog[57]	Los Angeles	J Emerg Med	1987	2	8	25.0	2	56	3.6	4	64	6.3	2	16	12.5
Feliciano[58]	Houston	Am J Surg	1986	18	91	19.8	7	186	3.8	25	277	9.0	2	53	3.8
Schwab[59]	Norfolk	Am Surg	1986	13	18	72.2	1	18	5.6	14	36	38.9	0	14	0.0
Washington[68*†]	Detroit	Ann Thorac Surg	1985							8	55	14.5			
Danne[43]	Washington, DC	J Trauma	1984	9	27	33.3	1	33	3.0	10	60	16.7	0	29	0.0
Vij[44*]	Detroit	Surgery	1983							5	57	8.8	0	6	0.0
Bodai[69‡]	Davis	J Trauma	1982										0	38	0.0
Flynn[42*]	Houston	Ann Emer Med	1982							4	13	30.8	0	20	0.0
Baker[47]	San Francisco	J Trauma	1980	24	60	40.0	8	48	16.7	32	108	29.6	1	60	1.7
Oparah[63†]	Los Angeles	J Thorac Cardiovasc	1979	2	6	33.3	0	8	0.0	2	14	14.3			
MacDonald[64]	Long Beach	JACEP	1978	2	13	15.4	1	13	7.7	3	26	11.5	0	2	0
Total				165	984	16.8	74	1,712	4.3	273	3,173	8.8	15	1,047	1.4

*Penetrating injury not separated.
†Blunt trauma data not available.
‡Blunt trauma data available only.
EDT, emergency department thoracotomy.

Table 3. Survival Rates of Emergency Department Thoracotomy Based on Location of Major Injury

				Cardiac injury			Thoracic injury			Abdominal injury			Multiple injury		
First author	Location	Journal	Year	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)
Branney[45]	Denver	J Trauma	1998	8	156	5.1	27	457	5.9	9	124	7.3			
Rhee[70]	Seattle	J Trauma	1998	15	58	25.9									
Asensio[71]	Los Angeles	J Trauma	1998	10	71	14.1									
Velmahos[52]	Johannesburg	Arch Surg	1995	13	108	12.0	32	160	20.0	8	118	6.8	1	501	0.2
Millham[66]	Boston	J Trauma	1993				13	290	4.5						
Mitchell[72]	Mississippi	J Trauma	1993	7	47	14.9									
Durham[53]	Houston	J Trauma	1992	18	135	13.3	27	230	11.7	5	124	4.0			
Esposito[48]	Seattle	J Trauma	1991				1	20	5.0						
Ivatury[55]	Bronx	J Trauma	1991	12	56	21.4	13	65	20.0	0	19	0.0	2	42	4.8
Jebara[73]	Beirut	Ann Thorac Surg	1989	4	17	23.5									
Ivatury[67]	Bronx	J Trauma	1987				10	100	10.0						
Ivatury[74]	Bronx	Am Surg	1987	28	118	23.7									
Feliciano[58]	Houston	Am J Surg	1986							5	185	2.7			
Schwab[59]	Norfolk	Am Surg	1986	13	18	72.2	13	20	65.0	1	31	3.2			
Washington[69]	Detroit	Ann Thorac Surg	1985	5	14	35.7	2	20	10.0	0	16	0.0	0	4	0.0
Danne[43]	Washington, DC	J Trauma	1984				9	54	16.6	1	6	16.7			
Demetriades[75]	Johannesburg	Br J Surg	1984	1	11	9.1									
Taveres[76]	Baltimore	Ann Thorac Surg	1984	21	37	56.8									
Vij[44]	Detroit	Surgery	1983	2	9	22.2	4	44	11.4	0	2	0.0	1	35	2.9
Rohman[77]	New York	J Trauma	1983	24	91	26.4									
Baker[47]	San Francisco	J Trauma	1980	18	63	28.6									
Mandal[78]	Los Angeles	Br J Surg	1979	1	18	5.6									
Flynn[42]	Houston	Ann Emerg Med	1982				4	7	57.1	0	6	0.0			
Oparah[63]	Los Angeles	J Thorac Cardiovasc	1979	2	13	15.4	0	1	0.0						
MacDonald[64]	Long Beach	JACEP	1978	3	18	16.7	3	25	12.0	0	9	0.0	0	8	0.0
Total				205	1,058	19.4	158	1,493	10.7	29	640	4.5	4	590	0.7

EDT, emergency department thoracotomy.

Analysis stratified by LOMI yielded survival rates of 10.7% for thoracic injuries, 4.5% for abdominal injuries, and 0.7% for multiple injuries. If the thoracic injury was predominantly cardiac, the survival rate was 19.4% (Table 3).

Patients with SOL in the hospital had survival rates of 11.5% in contrast to 2.6% for the patients with no SOL at the time they reached the hospital. Further stratification demonstrated that survival rates were 8.9% if the patient had SOL during transport and 1.2% if there were no SOL in the field (Table 4).

Of those studies reporting neurologic outcomes, normal neurologic outcomes were noted in 92.4% of the EDT patients who survived to discharge (Table 5).

DISCUSSION

This report emphasizes the key factors that influence the result of EDT. They are the MOI, LOMI, and SOL. To achieve optimal outcomes, only after considering all three of these factors should the physician decide whether to perform this procedure. When examining the results by mechanism, stab wounds have the best results and blunt trauma the worst outcomes. But the survival rate of 1.4% in blunt trauma cannot be ignored. Although survival is rare, other considerations aside from the MOI must be taken into account when considering EDT, such as the possibility of atrial rupture after blunt trauma in someone who has just lost SOL in the hospital. The control of hemorrhage from this type of injury is much more amenable compared with other injuries, such as pelvic fracture. Cardiac injuries have better outcomes than abdominal or multiple injuries, regardless of whether they are by stabbing, gunshot, or blunt trauma. Although the survival rate for noncardiac injuries is less favorable, the basis for performing an EDT is usually a strong suspicion for cardiac injuries in someone who has sustained thoracic injuries. Although it is recognized that cardiac injuries have the best outcomes, when assessing the patient with thoracic injuries, it is very difficult to rapidly determine whether the patient has an isolated cardiac injury until the chest has been opened. With the addition of the focused ultrasound, rapid assessment for possible cardiac injuries may further help define the role of EDT.

Numerous reports on EDT have been written in the past 25 years. In general, results have been similar regardless of how the data were collected and analyzed. The reporting sites include single institutions with frequent updates every few years, and institutions reporting once on a small number of patients. Some reports are by emergency room physicians, but most are by surgeons. The common theme in these reports is that survival from EDT occurs in a wide variety of circumstances in which the patient would have certainly died had it not been for the use of EDT. The results depend highly on the circumstance under which they are performed. The survival rate can be as high as 50% for those who arrive with SOL and then arrest in the hospital after a single stab wound to the left chest. In contrast, survival of patients without SOL after multiple injuries resulting from blunt trauma is extremely rare even in the best of hands. Most physicians who perform this procedure would agree that the rarity of the survivors might make EDT unwise in this situation.

Despite the general morbidity of the procedure, the overall survival rate of 7.4% demonstrates the efficacy of this procedure in selective situations in which the alternative is certain death. The reported normal neurologic function in 92.4% of these patients is also a testament to the usefulness of this procedure. The studies that reported cost benefit analysis demonstrated that the procedure does provide a longterm benefit. Cost data ranged from approximately $892 to $7,200 for the procedure, depending on whether they included the operating room costs.[40-45] Mazorrana and colleagues[40] reported that the charge for a trauma activation was $2,200 and the additional cost for the EDT was $1,213. Their experience resulted in 10 neurologically intact survivors out of 273 who underwent EDT. This equated to a charge of $93,175 per successful EDT. If EDT was restricted to only patients with penetrating trauma who present with SOL, the cost could be reduced to $20,137 per successful EDT. For survivors of penetrating injury, Boyd and associates[41] reported their cost as $109,025 and Hoyt and coworkers[46] reported $100,800 per survivor. Cost per life saved estimated by Baker and colleagues[47] in 1980 was $13,674 and in their calculations, the cost benefit analysis revealed that total benefits were 2.4 times greater than total costs. Esposito and associates[48] stated that there was a loss

Table 4. Survival Rates of Emergency Department Thoracotomy Based on SOL

				SOL hospital			No SOL hospital			SOL transport			No SOL field		
First author	Location	Journal	Year	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)	Survivors	EDT performed	Survival rate (%)
Branney[45]	Denver	J Trauma	1998	21	160	13.1							12	624	1.9
Brown[51]	Indiana	Am Surg	1996	4	57	7.0	0	80	0.0	4	106	3.8	0	31	0.0
Velmahos[52]	Johannesburg	Arch Surg	1995	42	710	5.9	1	136	0.7						
Mazzorana[40]	Oakland	Am Surg	1994	8	38	21.1	2	235	0.9	2	22	9.1	0	205	0.0
Esposito[49]	Seattle	J Trauma	1991										0	58	0.0
Ivatury[55]	Bronx	J Trauma	1991	8	23	34.8				8	57	14.0	0	25	0.0
Roberge[79]	New York	Am J Emerg Med	1986	4	14	28.6	3	30	10.0	3	21	14.3	0	9	0.0
Washington[69]	Detroit	Ann Thorac Surg	1985	5	19	26.3				3	19	15.8	0	12	0.0
Danne[43]	Washington, DC	J Trauma	1984	6	13	46.2	3	76	3.9						
Flynn[42]	Houston	Ann Emerg Med	1982	4	12	33.3	0	21	0.0						
Baker[47]	San Francisco	J Trauma	1980	27	77	35.1	6	91	6.6						
Oparah[63]	Los Angeles	J Thorac Cardiovasc	1979	1	5	20.0	1	9	11.1						
MacDonald[64]	Long Beach	JACEP	1978	0	5	0.0	2	23	8.7						
Total				130	1,133	11.5	18	701	2.6	20	225	8.9	12	964	1.2

EDT, emergency department thoracotomy; SOL, signs of life.

Table 5. Survivors with Normal Neurologic Outcomes after Emergency Department Thoracotomy

First author	Location	Journal	Year	Survivors with normal neurologic outcomes	Total number of survivors	Normal neurologic rate (%)
Branney[45]	Denver	J Trauma	1998	34	41	82.9
Bleetman[50]	UK	Injury	1996	1	1	100.0
Brown[51]	Indiana	Am Surg	1996	4	4	100.0
Velmahos[52]	Johannesburg	Arch Surg	1995	40	43	93.0
Mozzorana[40]	Oakland	Am Surg	1993	10	10	100.0
Millham[66]	Boston	J Trauma	1993	9	13	69.2
Durham[53]	Houston	J Trauma	1992	32	32	100.0
Boyd[41]	Youngstown	J Trauma	1992	2	2	100.0
Esposito[48]	Seattle	J Trauma	1991	1	2	50.0
Ivatury[55]	Bronx	J Trauma	1991	16	17	94.1
Lewis[56]	Cape Town	Injury	1991	8	8	100.0
Ordog[57]	Los Angeles	J Emerg Med	1987	5	6	83.3
Feliciano[58]	Houston	Am J Surg	1986	24	25	96.0
Roberge[68]	New York	Am J Emerg Med	1986	7	7	100.0
Brautigan[60]	East Lansing	Am J Emerg Med	1985	3	4	75.0
Danne[43]	Washington, DC	J Trauma	1984	9	10	90.0
Vij[44]	Detroit	Surgery	1983	4	5	80.0
Shimazu[61]	Baltimore	J Trauma	1983	4	5	80.0
Flynn[42]	Houston	Ann Emerg Med	1982	4	4	100.0
Baker[80]	San Francisco	Am J Surg	1980	32	33	97.0
Oparah[63]	Los Angeles	J Thorac Cardiovasc	1979	2	2	100.0
MacDonald[64]	Long Beach	JACEP	1978	2	2	100.0
Mattox[65]	Houston	JACEP	1974	27	27	100.0
Total				280	303	92.4

of $557 per patient but this was comparing charges against collections, whereas the other studies examined costs.[48] A sophisticated cost benefit analysis was performed by Branney and colleagues.[45] Their analysis took into consideration the cost of maintaining patients with closed head injury to the age of 65 in addition to the costs of EDT and operating room costs. The benefits calculations assumed that no survivor had more than an eighth-grade education and that individuals were employed until the age of 65. Accounting for the life-long costs of maintaining patients with closed head injuries resulted in a benefit to charge ratio of 1.8:1. Even in the worst case scenario, it may be of benefit because it is difficult to put a price on the salvage of a life. But the cost of transporting futile traumatic cardiac arrest patients has also been documented.[49]

Unfortunately, there is currently no single prehospital predictor of death. Hypotension, absence of any measurable blood pressure, and even CPR cannot uniformly predict death, because there are consistently survivors in all of these categories. The absence of SOL in the field alone results in poor outcomes with rare survivors. In the institution that reports the highest survival rate in patients without SOL in the field, the success of survival with normal neurologic function is still relatively low. To assist in the assessment of the patients SOL, Ivatury and colleagues[55] have recommended telemetry during transport to the receiving center to aid in making the decision to perform EDT. Some authors have reported their data such that two of the factors are taken into consideration, but rarely do any report all three in combination. Future reports would be of benefit if data were collected in a prospective fashion using all three factors (MOI, LOMI, SOL) in combination from multiple institutions. Data should be segregated by MOI. Within each category of the MOI (stab wound, gunshot wound, blunt), survival to discharge should be further sub-

divided by LOMI and SOL. This would demonstrate outcomes taking into account all of the three variables.

We recommend these general indications for EDT:

1. Indications for EDT: patients with penetrating thoracic injuries with SOL in the field who do not respond to fluids and are losing their vital signs in the resuscitation area.
2. Relative indications for EDT: patients with penetrating abdominal injury with at least one clear SOL in the field. Blunt trauma patients who lose SOL in the hospital or immediately before arrival.
3. Contraindication for EDT: patients without any SOL in the field from either penetrating or blunt trauma.

In summary, EDT is a useful tool in the desperate attempt to resuscitate trauma patients who are in extremis. This procedure has the best results when used on patients with thoracic trauma or cardiac injuries. Survival rates are low for those with abdominal hemorrhage or blunt trauma. Survival rates are also very poor for patients who do not have signs of life in the field. If applied selectively, this procedure can be lifesaving. Those who care for the injured should take into account all three factors—MOI, LOMI, and SOL—when deciding who would benefit the most from this dramatic procedure. Future studies should take into account all three of these factors in combination when reporting success rates after EDT. Indiscriminate use of the procedure can be costly to patients, care providers, and health care systems, yet appropriate use can be lifesaving.

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