POSITION PAPER

GUIDELINES FOR WITHHOLDING OR TERMINATION OF RESUSCITATION IN PREHOSPITAL TRAUMATIC CARDIOPULMONARY ARREST:

A JOINT POSITION PAPER FROM THE NATIONAL ASSOCIATION OF EMS PHYSICIANS STANDARDS AND CLINICAL PRACTICE COMMITTEE AND THE AMERICAN COLLEGE OF SURGEONS COMMITTEE ON TRAUMA

Laura R. Hopson, MD, Emily Hirsh, MD, Joao Delgado, MD, Robert M. Domeier, MD, Norman E. McSwain, Jr., MD, Jon Krohmer, MD

POSITION STATEMENT

The National Association of EMS Physicians and the American College of Surgeons Committee on Trauma support out-of-hospital withholding or termination of resuscitation for adult traumatic cardiopulmonary arrest (TCPA) patients who meet specific criteria:

1. Resuscitation efforts may be withheld in any *blunt* trauma patient who, based on out-of-hospital personnel's thorough primary patient assessment, is found apneic, pulseless, and without organized electrocardiographic (ECG) activity upon the arrival of emergency medical services (EMS) at the scene.
2. Victims of *penetrating* trauma found apneic and pulseless by EMS, based on their patient assessment, should be rapidly assessed for the presence of other signs of life, such as pupillary reflexes, spontaneous movement, or organized ECG activity. If any of these signs are present, the patient should have resuscitation performed and be transported to the nearest emergency department (ED) or trauma center. If these signs of life are absent, resuscitation efforts may be withheld.
3. Resuscitation efforts should be withheld in victims of pene-trating or blunt trauma with injuries obviously incompatible with life, such as decapitation or hemicorporectomy.
4. Resuscitation efforts should be withheld in victims of penetrating or blunt trauma with evidence of a significance time lapse since pulselessness, including dependent lividity, rigor mortis, and decomposition.
5. Cardiopulmonary arrest patients in whom the mechanism of injury does not correlate with clinical condition, suggesting a nontraumatic cause of the arrest, should have standard resuscitation initiated.
6. Termination of resuscitation efforts should be considered in trauma patients with EMS-witnessed cardiopulmonary arrest and 15 minutes of unsuccessful resuscitation and cardiopulmonary resuscitation (CPR).
7. Traumatic cardiopulmonary arrest patients with a transport time to an ED or trauma center of more than 15 minutes after the arrest is identified may be considered nonsalvageable, and termination of resuscitation should be considered.

From the Department of Emergency Medicine, University of Michigan Health System (LRH), Ann Arbor, Michigan; the Department of Emergency Medicine, North Shore University Hospital (EH), Manhasset, New York; the Rocky Mountain Poison and Drug Center, Denver Health (JD), Denver, Colorado; the Department of Emergency Medicine, Saint Joseph Mercy Hospital (RMD), Ann Arbor, Michigan; Tulane University School of Medicine, Charity Hospital (NEM), New Orleans, Louisiana; and Kent County EMS, Michigan State University College of Human Medicine (JK), Grand Rapids, Michigan.

Address correspondence and reprint requests to: Robert M. Domeier, MD, Saint Joseph Mercy Hospital, P.O. Box 995, 5301 E. Huron River Drive, Ann Arbor, MI 48106. e-mail: <rdomeier@aol.com>.

8. Guidelines and protocols for TCPA patients who should be transported must be individualized for each EMS system. Consideration should be given to factors such as the average transport time within the system, the scope of practice of the various EMS providers within the system, and the definitive care capabilities (that is, trauma centers) within the system. Airway management and intravenous (IV) line placement should be accomplished during transport when possible.

9. Special consideration must be given to victims of drowning and lightning strike and in situations where significant hypothermia may alter the prognosis.

10. EMS providers should be thoroughly familiar with the guidelines and protocols affecting the decision to withhold or terminate resuscitative efforts.

11. All termination protocols should be developed and implemented under the guidance of the system EMS medical director. Online medical control may be necessary to determine the appropriateness of termination of resuscitation.

12. Policies and protocols for termination of resuscitation efforts must include notification of the appropriate law enforcement agencies and notification of the medical examiner or coroner for final disposition of the body.

13. Families of the deceased should have access to resources, including clergy, social workers, and other counseling personnel, as needed. EMS providers should have access to resources for debriefing and counseling as needed.

14. Adherence to policies and protocols governing termination of resuscitation should be monitored through a quality review system.

DISCUSSION

Injury is the leading cause of death for Americans between the ages of 1 and 44 years. The EMS system is the portal into the medical system for many of the most seriously injured trauma victims. Some of these patients will be unsalvageable due to the extent of their injuries. In order to preserve dignity, conserve precious human and financial resources, and to minimize risks to the health care workers involved, patients who can be predicted to be unsalvageable should not be transported emergently to the ED or trauma center.

The decision to withhold or terminate resuscitation attempts in the field is a difficult one.[1] It has long been apparent that prehospital TCPA confers a dismal prognosis. However, a small subset of these patients may be salvaged with timely interventions. This potential salvage of a small percentage of patients with TCPA must be weighed against the inherent costs and risks of resuscitation attempts. First, trauma resuscitations consume significant amounts of ED, operating room, and intensive care unit resources. Second, significant risk for the EMS crews and the public is associated with emergency transport. Third, the chaotic environment of trauma resuscitations may pose a heightened risk of blood-borne pathogen exposure to the involved health care workers. These considerations argue for the thoughtful development and utilization of sensible guidelines for resuscitation of TCPA patients based on the best available evidence.

Literature Review

Prehospital Traumatic Cardiopulmonary Arrest

Much of the data about predictors of survival in prehospital TCPA patients must be extrapolated from emergency thoracotomy research.

A few studies, however, have looked specifically at predictors of survival in prehospital TCPA. The available literature must be viewed with the knowledge that most studies are retrospective series and that the small number of survivors in any given study limits the validity of the study conclusions. It is clear that, overall, TCPA has a grim prognosis.

Shimazu and Shatney, in a case series of 267 TCPA patients with blunt and penetrating trauma, reported seven of the 267 survived long term, with only four returning to their preinjury level of neurologic function.[2] This series reported a 4% survival rate in patients with an arrest due to penetrating trauma and a 2.3% survival rate for blunt TCPA. It is interesting to note that in this series, three of the five survivors of blunt TCPA were observed to have only isolated head trauma. Rosemurgy et al. retrospectively reviewed 410 EMS run sheets involving a prehospital TCPA.[3] Patients deemed to have injuries incompatible with life were excluded from the analysis, leaving a group of 138 patients that included 96 blunt and 42 penetrating injuries. This group consisted of patients without vital signs at some point in the prehospital course. All of the patients ultimately died.

Stratton et al. examined the prehospital records of 1,051 patients with prehospital TCPA.[4] Excluding 116 patients who were pronounced dead in the field or who met other exclusionary criteria, such as primary cardiac arrest, burns, or incomplete data, 879 unconscious and pulseless patients were transported emergently. Of the 497 victims of penetrating trauma, four (0.8%) survived, including one in a neurologically devastated state. Five (1.6%) survivors out of 382 blunt TCPA patients were neurologically devastated. Battistella et al., in their series of 604 trauma victims who required CPR, including almost equal numbers of penetrating trauma and blunt trauma,

reported a 2.6% (16/604) survival rate, with 75% of the survivors having sustained penetrating trauma.[5] Seven of the 16 survivors had severe neurologic deficits. All survivors had detectable blood pressures in the field but subsequently lost vital signs.

Fulton et al., in their series, showed a survival rate of 2.4% (6/245) for patients in TCPA.[6] All survivors had a Glasgow Coma Scale score of 9 or greater at the scene of injury, implying significant initial cerebral perfusion and a subsequent loss of vital signs. Finally, Pasquale et al analyzed 106 adults who required prehospital CPR and found only three survivors, one having sustained penetrating trauma and two with blunt trauma.[7]

In a recent series of 193 trauma patients presenting to a trauma center with CPR in progress, McSwain reported five (2.6%) survivors to hospital discharge. For survivors, presenting rhythm was sinus in one patient, sinus tachycardia in three, and asystole in one. The presenting patient population was 61% penetrating trauma, 34% blunt trauma, and 5% of injuries due to burns, cold, or asphyxiation. Mechanism of injury in the survivors was not reported (McSwain NE, personal communication, 2001).

Initial Electrocardiographic Rhythm

There is some evidence that the initial ECG rhythm obtained by EMS may be predictive of survival. In the series by Battistella et al., none of the 212 initially asystolic TCPA patients survived.[5] Severely bradycardic trauma patients with heart rates of less than 40 beats/min also had no survivors out of a group of 134. All 16 TCPA survivors had initially detectable systolic blood pressures with a subsequent loss of vital signs and pulseless electrical activity (PEA) and sinus rhythm between 80 and 150 beats/min. The authors of this study argued that prehospital triage criteria of PEA with a heart rate of less than 40 beats/min may be reliable in discriminating unsalvageable from potentially salvageable victims.

Fulton et al. found improved survival in those TCPA patients with ventricular fibrillation, ventricular tachycardia, or PEA as opposed to asystole or idioventricular rhythm.[6] All patients in their series with asystole or idioventricular rhythms died. Stratton et al., likewise, noted that the survivors in their series had sinus-based PEA. They also noted that the presence of this rhythm did not have a significant positive predictive value for survival due to extremely small numbers of overall survivors from an arrested state.[4]

Esposito et al. documented initial ED cardiac rhythm in 102 TCPA patients.[8] Of 17 patients with a sinus-based rhythm, one (5.9%) survived. Of 14 patients in ventricular fibrillation, one (7.1%) survived. Of 57 patients with idioventricular rhythm, there were no survivors. There also were no survivors among the 16 patients presenting with asystole.

Aprahamian et al. reported that all TCPA patients presenting in PEA and asystole ultimately died.[9] The three survivors out of 95 patients with TCPA all arrested in the ED, developed ventricular fibrillation, and were successfully defibrillated during their ED courses. These studies suggest that presence of an ECG rhythm, such as asystole, idioventricular rhythm, or severe bradycardia, is indicative of an unsalvageable patient. Those patients with a sinus-based PEA may represent a potentially salvageable subset of TCPA patients. It must still be recognized that TCPA in itself is a grave event; the presence of any particular ECG rhythm as an indicator of survival is of limited significance. The studies presented here do not differentiate between blunt and penetrating causes of TCPA. The abysmal survival rate demonstrated with blunt TCPA in other studies suggests that most survivors in the studies of rhythm as a predictor of survival are likely cases of penetrating trauma.

Resuscitation Duration

Duration of closed-chest CPR for TCPA patients has also been shown to affect prognosis. Fulton et al.'s series of 245 TCPA patients showed no survivors when CPR lasted more than 10 minutes or among those who sustained a second cardiac arrest.[6] Mattox and Feliciano found no survivors in a case series of 100 TCPA patients who required more than 3 minutes of closed-chest CPR.[10] Two of Pasquale et al.'s three survivors required less than 5 minutes of CPR; the third was a patient with an isolated penetrating chest wound who had less than 15 minutes of CPR.[7] Durham et al. reported a difference between survivors and nonsurvivors in terms of the length of CPR delivered.[11] Survivors had shorter prehospital CPR times averaging 5 minutes, as opposed to 9 minutes in nonsurvivors. The data collectively suggest that a patient with TCPA and more than a 15-minute transport time while in arrest will not survive, regardless of the aggressiveness of the care delivered.

ED Thoracotomy

Although thoracotomy is not a procedure that falls under the purview of prehospital care, the literature is relevant in defining those patients who might benefit from transport to a facility that can perform this procedure. The emergency thoracotomy (ET) literature consists exclusively of retrospective case series that vary considerably in size. In addition, there was wide variability among the patients included in the various studies and the circumstances under which an ET is deemed indicated. Consequently, the survival rates obtained vary significantly, ranging from 2% to 31%. In general, the studies citing higher survival rates included significantly larger proportions of patients

TABLE 1. Summary of Major Studies of Emergency Thoracotomy

Study	No. of Patients	Survivors*			ED‡				EMS‡	
		Long-term	Blunt	Penetrating	−VS −SoL	−VS +SoL	+VS +SoL	−VS EMS +SoL/VS	−VS −SoL	+VS +SoL
Mattox et al.,[12] 1974	106	33/106 (31%)	3/19	30/87	—	—	33/73	0/33	—	—
MacDonald and McDowell,[13] 1978	28	2/28 (11%)	0/2	2/26	—	2/23	0/5	—	—	—
Moore et al.,[14] 1979	146	8/146 (5%)	0/27	8/121	—	5/128	3/18	—	—	—
Baker et al.,[15] 1980	168	33/168 (24%)	1/60	32/108	—	10/111	23/57	—	—	—
Harner et al.,[16] 1981	100	20/100 (20%)	8/65†	16/35†	—	—	11/42†	13/58†	—	—
Flynn et al.,[17] 1982	33	4/33 (12%)	0/20	4/13	—	0/21	4/12	—	—	—
Cogbill et al.,[18] 1983	400	12/400 (3%)	0/195	12/205	—	5/28	—	6/102	1/264	—
Danne et al.,[19] 1984	89	10/89 (11%)	0/29	10/60	—	—	7/13	—	—	10/10
Washington et al.,[20] 1985	55	8/55 (15%)	—	8/55	—	—	5/24	3/19	0/12	—
Ordog,[21] 1987	80	5/80 (6%)	2/16	3/64	—	—	—	—	—	—
Clevenger et al.,[22] 1988	72	3/72 (4%)	0/31	3/41	—	—	3/22	0/27	0/23	—
Hoyt et al.,[23] 1989	113	33/113 (29%)	0/39	33/74	—	—	20/33	—	—	—
Rothenberg et al.,[24] 1989	83	3/83 (4%)	1/47	2/36	—	1/69	2/14	0/58	—	—
DiGiacomo and Odom,[25] 1990	93	6/93 (7%)	0/17	6/76	—	6/93	—	—	—	—
Esposito,[8] 1991	112	2/112 (2%)	1/88	1/24	—	—	1/15	—	0/58	2/37
Ivatury,[26] 1991	163	16/163 (10%)	0/29	16/134	—	—	8/23	8/57	0/25	—
Lorenz,[27] 1992	463	61/463 (13%)	3/194	58/269	—	—	57/96	—	0/215	—
Durham,[11] 1992	387	32/387 (8%)	0/69	32/318	—	17/207	—	—	—	—
TOTALS	2,691	291/2,691 (11%)	19/947* (2%)	276/1,746* (16%)						

*Unless otherwise indicated, "survivors" denotes neurologically intact individuals. The results are reported as number of survivors/number of individuals in injury category.

†Includes neurologically devastated individuals.

‡ED = status on initial emergency department assessment; EMS = status on initial assessment by emergency medical services; +VS = presence of vital signs; −VS = absence of vital signs; +SoL = presence of signs of life (e.g., spontaneous movement, spontaneous respirations, or pupillary reflexes) in the absence of other vital signs; −SoL = absence of signs of life. The results are reported as number of survivors/number of individuals in category.

merely with severe shock and more recent onset of TCPA than those studies reporting lower survival rates. Because the survival rate tends to be poor, the small number of survivors hampers drawing conclusions from any one study. Analysis of the literature is also complicated by a marked variation in methods of data reporting as to the duration of cardiopulmonary arrest relative to the performance of the thoracotomy.

Despite these significant limitations, the ET literature, as summarized in Table 1, does have relevance to the topic at hand.[8,11,12–27] Several trends can be extrapolated. ET does not appear to have a role in TCPA as a result of blunt trauma, with reported survival rates averaging less than 2% overall. TCPA secondary to penetrating trauma, while still having a dismal prognosis, may be more amenable to salvage with ET, particularly in the case of isolated penetrating trauma to the thorax. Studies have repeatedly demonstrated that the majority of survivors came from this category.[12,15,16,19,23,25,26] In addition, there is clearly a correlation between length of time between TCPA and performance of a thoracotomy. Not surprisingly, those studies with high proportions of patients arresting in the ED or with merely severe hypotension (systolic blood pressure <60 mm Hg) demonstrated the best survival rates, ranging from 12% to 31%.[12,15–17,19,23,27] Those studies with larger proportions of patients without vital signs or other significant signs of life at the scene of injury showed very poor survival rates.[8,18,22,27]

The prehospital implications of these studies are significant. At the scene of blunt injury, patients without vital signs or, in the case of penetrating trauma, patients without vital signs or other significant signs of life will not survive even with the most aggressive of therapies. Therefore, resuscitation and emergent transport of these TCPA victims are not warranted. Of patients who sustain TCPA, data suggest that penetrating trauma isolated to the thorax is the most salvageable subset of patients and any signs of life at the time of EMS arrival may reflect a potential survivor.

Rapid Transport versus Field Stabilization

The question of which patients with severe traumatic injuries should be transported without delay and which patients might benefit from on-scene stabilization has spurred continuing debate over many years.[11,22,28–30] Proponents of opposing positions have been equally emphatic as to the merits of each approach, and

the literature on this topic suffers from multiple methodological limitations. Despite conflicting reports and recommendations, some generalizations can be made based on the available evidence. Consistent with data from the ET literature, in the case of TCPA, expeditious transportation of a patient deemed to be potentially salvageable to a trauma center for definitive treatment is crucial.

Gervin and Fischer reported a single institution's experience of patients who had suffered penetrating cardiac wounds.[31] In their series of 13 patients with salvageable wounds, six patients were transported immediately, with a mean on-scene time of 9 minutes, and seven patients underwent extensive resuscitation attempts in the field, with a mean on-scene time of 40 minutes. The first group had a 67% survival rate; there were no survivors in the second group.

Copass et al reported their three-year experience of 131 patients who required CPR as a result of a TCPA.[32] Patients who survived had a 97% rate of successful endotracheal tube placement, whereas only 65% of the nonsurvivors had successful tube placement. In addition, all 30 survivors had two IV lines inserted, compared with only 70% in the nonsurvivors. The transport time was 2 minutes longer for the surviving group, but this figure did not reach statistical significance. This experience suggests that performing advanced airway and advanced life support (ALS) procedures may improve survival rates.

Potter et al. compared the outcomes of 472 trauma patients who received ALS with 589 similar patients who received only basic life support (BLS).[33] Although this study did not specifically address traumatic arrest, the results were noteworthy in that there appeared to be no difference in long-term outcomes between the two groups.

Honigman et al. examined the outcomes of 70 consecutive patients with penetrating cardiac injuries, specifically in relation to prehospital procedures performed and the time consumed to complete them.[34] The authors reported a 30% survival rate and noted that the total number of procedures performed did not prolong on-scene times. Of the 43 patients who had no vital signs at the scene, there were only three survivors, all of whom were stabbing victims.

In addition to the need for expedient transport, TCPA patients appear to benefit from interventions such as intubation and IV line insertion. Time is critical, and TCPA lasting more than 10–15 minutes in the field is a lethal event. It appears that, at least in urban settings with short EMS transport times, ALS interventions may be lifesaving if they can be performed in a timely fashion.

Air Medical Transport

Two studies have specifically addressed the transport of TCPA patients. Wright et al. retrospectively reviewed one flight program's experience over a three-year period.[35] The authors identified 67 patients who had experienced TCPA prior to the arrival of the flight crew, 20 of whom were pronounced dead prior to transport. The other 47 patients were transported to the ED, with no survivors to discharge in the group. Margolin et al. found somewhat different results.[36] Their series included 67 patients with documented prehospital TCPA. A surprising 19% survived, of whom 46% were able to return to independent living. These unusually good outcomes are likely explained, at least in part, by selection bias. The majority of the patients were transported from another hospital and not from the scene. In addition, the patients who died en route to the initial hospital were not included in the analysis. Nevertheless, these results may indicate that for a select group of patients who are successfully resuscitated, prompt transfer to a trauma center may confer a survival benefit.

Pediatrics

The recommendations contained within this paper do not extend to the pediatric population. Although many of the studies on which our recommendations are based included children, the vast majority of the patients were adults. Two studies have addressed the pediatric population in particular. Hazinski et al evaluated survival and functional outcome of 38 pediatric blunt trauma victims with either full TCPA or severe hypotension.[37] Of these, there were no functional survivors. Suominen et al. examined the experience with resuscitation of pediatric trauma patients in Finland.[38] In their retrospective study over a ten-year span, two patients survived of 41 patients with no detectable vital signs. Although the study had several limitations, including small numbers and selection bias, the poor outcome reported was consistent with outcomes reported in other series. These series suggest that the prognosis for pediatric TCPA victims is likely similar to that for adults. With the emotional demands of withholding resuscitation from a child in the field, additional studies may be warranted before including children in any protocol that allows for withholding or terminating resuscitation in TCPA patients.

Exceptions

Situations in which trauma is complicated by significant hypothermia should not be included in these recommendations. Profound hypothermia below 32°C will cause progressive bradycardia, decreased cardiac output, loss of consciousness, and, ultimately, loss of brainstem reflexes—effectively mimicking death, but with the potential for successful resuscitation with appropriate medical treatment and rewarming.[39] Examples of hypothermia complicating trauma may include cold water submersion (particularly in children), avalanche burial, and

minor trauma with subsequent environmental exposures. In these situations, patients should be aggressively resuscitated and transported to a center capable of aggressively rewarming the victim.

SUMMARY

Survival after TCPA is rare, even with maximal resuscitative efforts. Penetrating trauma, particularly if isolated to the thorax, has a better prognosis than blunt or multisystem penetrating trauma. Survival from cardiopulmonary arrest due to blunt trauma is grave indeed, likely due to the multisystem nature of the injuries sustained.

The recommendations presented in this paper are based on the available research to date and are subject to change based on advances in the care of the trauma patient. These recommendations specifically do not address 1) pediatric patients, 2) patients in whom a medical cause (such as myocardial infarction) is the likely inciting event, and 3) patients with complicating factors, such as the potential for severe hypothermia.

References

1. Bailey ED, Wydro GC, Cone DC. Termination of resuscitation in the prehospital setting for adult patients suffering nontraumatic cardiac arrest. National Association of EMS Physicians Standards and Clinical Practice Committee. Prehosp Emerg Care. 2000; 4:190–5.

2. Shimazu S, Shatney CH. Outcomes of trauma patients with no vital signs on hospital admission. J Trauma. 1983; 23:213–6.

3. Rosemurgy AS, Norris PA, Olson SM, Hurst JM, Albrink MH. Prehospital traumatic arrest: the cost of futility. J Trauma. 1993;35:468–73.

4. Stratton SJ, Brickett K, Crammer T. Prehospital pulseless, unconscious penetrating trauma victims: field assessments associated with survival. J Trauma. 1998;45:96–100.

5. Battistella FD, Nugent W, Owings JT, et al. Field triage of pulseless trauma patients. Arch Surg. 1999;134:742–6.

6. Fulton RL, Voigt WJ, Hilakos AS. Confusion surrounding the treatment of traumatic cardiac arrest. J Am Coll Surg. 1995;181:209–14.

7. Pasquale MD, Rhodes M, Cipolle MD, Hanley T, Wasser T. Defining "dead on arrival": impact on a Level I trauma center. J Trauma. 1996;41:726–30.

8. Esposito TJ, Jurkovich GJ, Rice CL, Maier RV, Copass MK, Ashbaugh DG. Reappraisal of emergency room thoracotomy in a changing environment. J Trauma. 1991;31:881–7.

9. Aprahamian C, Darin JC, Thompson BM, et al. Traumatic cardiac arrest: scope of paramedic services. Ann Emerg Med. 1985;14:583–6.

10. Mattox KL, Feliciano DV. Role of external cardiac compression in truncal trauma. J Trauma. 1982;22:934–6.

11. Durham LA, Richardson RJ, Wall MJ, Pepe PE, Mattox KL. Emergency center thoracotomy: impact of prehospital resuscitation. J Trauma. 1992;32:775–9.

12. Mattox KL, Espada R, Beall AC, Jordan GL. Performing thoracotomy in the emergency center. J Am Coll Emerg Physicians. 1974;3:13–7.

13. MacDonald JR, McDowell RM. Emergency department thoracotomies in a community hospital. J Am Coll Emerg Physicians. 1978;7:423–8.

14. Moore EE, Moore JB, Galloway AC, Eiseman B. Post injury thoracotomy in the emergency department: a critical evaluation. Surgery. 1979;86:590–8.

15. Baker CC, Thomas AN, Trunkey DD. The role of emergency room thoracotomy in trauma. J Trauma. 1980;20: 848–55.

16. Harnar TJ, Oreskovich MR, Copass MK, Heimbach DM, Herman CM, Carrico CJ. Role of emergency thoracotomy in the resuscitation of moribund trauma victims. Am J Surg. 1981;142:96–9.

17. Flynn TC, Ward RE, Miller PW. Emergency department thoracotomy. Ann Emerg Med. 1982;11:413–6.

18. Cogbill TH, Moore EE, Millikan JS, Cleveland HC. Rationale for selective application of emergency department thoracotomy in trauma. J Trauma. 1983; 23:453–60.

19. Danne PD, Finelli F, Champion HR. Emergency bay thoracotomy. J Trauma. 1984;24:796–802.

20. Washington B, Wilson RF, Steiger Z, et al. Emergency thoracotomy: a four year review. Ann Thorac Surg. 1985;40: 188–91.

21. Ordog GJ. Emergency department thoracotomy for traumatic cardiac arrest. J Emerg Med. 1987;5:217–23.

22. Clevenger FW, Yarbrough DR, Reines HD. Resuscitative thoracotomy: the effect of field time on outcome. J Trauma. 1988;28:441–5.

23. Hoyt DB, Shackford SR, Davis JW. Thoracotomy during trauma resuscitations—an appraisal by board-certified general surgeons. J Trauma. 1989; 29:1318–21.

24. Rothenberg SS, Moore EE, Moore FA, Baxter BT, Moore JB, Cleveland HC. Emergency department thoracotomy in children—a critical analysis. J Trauma. 1989;29:1322–5.

25. DiGiacomo JC, Odom JW. Resuscitative thoracotomy and combat casualty care. Milit Med. 1991;156:406–8.

26. Ivatury RR, Kazigo J, Rohman M, Gaudino J, Simon R, Stahl WM. "Directed" emergency room thoracotomy: a prognostic prerequisite for survival. J Trauma. 1991;31:1076–82.

27. Lorenz HP, Steinmetz B, Lieberman J, et al. Emergency thoracotomy: survival correlates with physiologic status. J Trauma. 1992;32:780–8.

28. Cayten CG, Murphy JG, Stahl WM. Basic life support versus advanced life support for injured patients with an injury severity score of 10 or more. J Trauma. 1993;35:460–7.

29. Jacobs LM, Sinclair A, Beiser A, et al. Prehospital advanced life support: benefits in trauma. J Trauma. 1984;24:8–13.

30. Smith P, Bodai BI, Hill AS, et al. Prehospital stabilization of critically injured patients: a failed concept. J Trauma. 1985;25:65–70.

31. Gervin AS, Fischer RP. The importance of prompt transport in salvage of patients with penetrating heart wounds. J Trauma. 1982;22:443–8.

32. Copass MK, Oreskovich MR, Bladergroen MR, Carrico CJ. Prehospital cardiopulmonary resuscitation of the critically injured patient. Am J Surg. 1984; 148:20–6.

33. Potter D, Goldstein G, Fung SC, Selig M. A controlled trial of prehospital advanced life support in trauma. Ann Emerg Med 1988;17:582–588

34. Honigman B, Rohweder K, Moore EE, Lowenstein SR, Pons PT. Prehospital advanced trauma life support for penetrating cardiac wounds. Ann Emerg Med. 1990;19:145–50.

35. Wright SW, Dronen SC, Combs TJ, Storer D. Aeromedical transport of patients with posttraumatic cardiac arrest. Ann Emerg Med. 1989;18:721–6.

36. Margolin DA, Johan DJ, Fallon WF. Response after out of hospital cardiac arrest in the trauma patient should determine aeromedical transport to a trauma center. J Trauma. 1996;41:721–5.

37. Hazinski MF, Chahine AA, Holcomb GW, Morris JA. Outcome of cardiovascular collapse in pediatric blunt trauma. Ann Emerg Med. 1994;23:1229–35.

38. Suominen P, Rasanen J, Kivioja A. Efficacy of cardiopulmonary resuscitation in pulseless pediatric trauma patients. Resuscitation. 1998;36:9–13.

39. Danzl DF. Accidental hypothermia. In: Rosen P (ed). Emergency Medicine: Concepts and Clinical Practice. 4th Ed. St. Louis, MO: Mosby, 1998.