Evacuation of Trauma Patients Solely to Level 1 Centers: Is the Question Patient or Trauma Center Survival?

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Three decades have elapsed since the inception of Level I trauma centers as the final link in the trauma system "chain of survival." During this period the simplistic 1960s model of the trauma system evolved into an inclusive trauma care plan for all trauma patients regardless of setting and/or severity of injury – a system encompassing prehospital care, trauma care facilities providing different levels of care, and rehabilitation services [1]. While this change does not render the Level I trauma center entirely obsolete, it has detracted from its exclusivity in treating complex trauma patients.

Definition of the trauma center

It is questionable whether patient outcome can be related to the designation of the treating trauma center in light of the controversy regarding the definition of such a center.

Neurosurgery – crucial or not?

It has traditionally been accepted that Level I trauma centers are exclusively capable of providing immediate neurosurgical care [2]. Recent years have seen a growing crisis in the availability of neurosurgeons and their willingness to be involved in the treatment of trauma patients [3]. Head injury is diagnosed in approximately 30% of trauma patients. The vast majority of head-injured patients (>95%) do not require operative management and only 1% of all trauma patients (2–4% of head-injured patients) require craniotomy and/or intracranial pressure monitoring. Interestingly, the United States National Trauma Data Bank data show that the median time from admission to craniotomy is 195 minutes. These findings led prominent trauma researchers to conclude: "Care of the trauma patient head injury rarely requires the explicit expertise and immediate presence of a neurosurgeon" [4].

The in-house trauma surgeon

The presence of an experienced surgeon at the initial assessment and care of the trauma patient is not the focal point of trauma center designation [2] but remains highly controversial. The only study addressing this issue showed that when the in-house trauma surgeon was actually present in the initial resuscitation, process indicators improved, the time to surgery was shorter (43.8 ± 20.1 versus 109.4 ± 107 minutes, $P < 0.05$), and there were no missed injuries or inappropriate workups [5]. Other studies, which demonstrated no ill effect on mortality outcome, did not examine whether the in-house attending surgeon actually participated in the initial resuscitation [6,7]. These issues are of particular importance in this country since none of the facilities designated as Level I have an in-house trauma surgeon.

Volume makes perfect?

Level I accreditation demands admission of at least 240 patients with Injury Severity Score above 15 per year, or that trauma surgeons care for at least 35 patients per year [2]. These recommendations are based on early studies showing that high volumes are associated with improved outcome [8,9]. More recent studies do not support these early findings and find no relationship between high volumes and improved outcome [10]. Importantly, the contribution of the overall experience of the surgeon to patient outcome has never been examined.

Rethinking the definition of a trauma center

The competition for designation as Level I trauma centers in the U.S. has brought about a demand to clarify the requirements for this designation [4]. The situation in this country is even more complex; a centralized accreditation body does not supervise designation of the facilities' level of trauma care. Numerous facilities in Israel that are not designated as Level I centers provide all/almost all of the services required for such designation [2] whereas Level I centers are often lacking in at least one criterion. The structure, affiliation, resources and vested interests of each facility may render differences in the care provided for specific injuries.

Efficacy of treatment in Level I centers

Performance assessment and outcome evaluation is still a major problem in trauma healthcare system research since structure and process indicators are rarely being used. Examples of such indicators are compliance rates with practice management guidelines or care protocols, rates of selected complications, inappropriate care rates, preventable death rates, and ratios of fatal to non-fatal injuries. For example, Helling et al. [11] found a highly significant difference in the treatment provided

to blunt trauma liver injuries; at Level II trauma centers most (77%) were managed non-operatively whereas in Level I centers only a minority (27%) was treated conservatively. Similar measures of potential over-treatment have not been examined. In view of the lack of structure and process indicators, mortality is being used as almost the sole outcome measure. Unfortunately, the improved survival and reduced morbidity observed with implementation [12] and maturation [13,14] of a trauma system is often confused with the concept that patient outcomes are only improved if evacuation is performed to Level I centers. The evidence regarding morbidity and mortality in this scenario is mostly of Grade B or C quality (Cochrane) and as such is inconclusive; no study showing improved outcomes in Level I centers is prospective and randomized and historical controls are often used. Even the largest study to date that did succeed in showing that Level I centers had significantly lower rates of mortality and severe disability at discharge when compared to Level II focused on a very specific subgroup of severely injured patients who constitute approximately 1% of all trauma patients [15]. Patients who expired from exsanguinations prior to arrival (a variable that may have been affected by the distance traveled) were not included and the regression model did not include time to arrival or measures of microcirculatory failure.

There is evidence of similar quality that trauma patients received optimal treatment irrespective of the designation of the trauma center that provided their treatment; patients admitted to Level I and II centers with specific vascular injuries had similar case fatalities and comparable hospital charges [16]. No difference was found in the outcome of patients with hepatic injuries treated in both types of centers with respect to severity of injury, mortality, delays to surgery, or hospital length of stay [11].

The accuracy and reproducibility of measures of anatomic injury severity are crucial when morbidity and mortality are the measures of outcome. The ISS is well established as the most frequently used measure of anatomic injury severity. Inconsistent generation of ISS among trauma centers often causes discrepancies in mortality rates for trauma patients [17] It is questionable whether the results of studies examining the outcomes of trauma patients in the U.S. are relevant to the hospital setup in this country in any case. Nonetheless, even the information regarding quality of treatment and outcomes in this country should be interpreted with caution. The National Trauma Databank in Israel receives data mostly from Level I trauma centers. Ministry of Health data suggest that the number of motor vehicle accident admissions may in fact be double that in the National Trauma Registry [14].

Changes in trauma therapy

The early mortality of severe trauma has a bimodal distribution: the first peak occurs within an hour of injury (50.2% of deaths) and the second 1–6 hours after admission (18.3% of deaths)

ISS = Injury Severity Score
ICU = intensive care unit

[18]. Rapid diagnosis and intervention targeted to alleviate the preventable causes of death form the basics of trauma management. Airway and breathing problems are often the cause of death in the first hour following injury and frequently depend on prehospital care. Failure to control hemorrhage – with the resultant deterioration into the vicious cycle of hypothermia, acidosis, coagulopathy and microcirculatory failure – constitutes the principal cause of death in the second peak of mortality and is heavily dependent on evacuation time and hospital performance.

Evacuation time

In patients with an ISS above 15 who were transported by non-emergency medical service laymen who happened to be on location, the mortality rate was half that of those transported by paramedics even after adjustment for ISS, probably due to briefer transport times (14.1% vs. 28.8%, relative risk 1.60, $P = 0.002$) [19]. Admission hypothermia in itself is clearly associated with more profound acidosis, prolonged intensive care unit/ventilator courses, and increased mortality [20].

Damage control surgery

The principle concept underlying the treatment of all severely injured trauma patients is reduction of the time spent in a state of physiologic imbalance. Thus, trauma units are designed to reduce the time from injury to life/limb-saving surgical intervention. The fundamental objective of the first phase of treatment in damage control is only to do enough to restore a survivable physiology and to this purpose operations are truncated. Damage control can be performed at Level II centers [21], making expeditious transport of the severely injured hemorrhaging trauma patient to a nearby Level II center preferable when transport time to the nearest Level I center is longer.

Non-operative treatment

Non-operative management of blunt solid organ and selective penetrating injuries has become acceptable and increasingly popular. The success of non-operative management is such that it has diminished the operative experience of trauma surgeons; this lack of operative trauma experience has become a major concern in some trauma centers [22]. No clear advantage has been demonstrated with non-operative management of specific injuries in Level I compared to Level II centers [23], and when this management was applied in a rural setting, significant reductions in hospital and ICU length of stays and in transfusion requirements were observed [24].

Conclusions

This article highlights the conundrums surrounding evacuation of all severely injured trauma patients directly to Level I trauma centers regardless of the distance from the site of the event. Prospective randomized data showing superiority in performance and/or outcome in Level I trauma centers are lacking. Moreover, current scoring systems designed to describe trauma patients' severity of injury are not entirely accurate and repro-

ducible. This limits the ability to draw scientific conclusions from existing literature. Selection of the receiving facility should not hinge solely upon its designation. In countries where accreditation for trauma designation is mandatory, the definition of Level I trauma centers remains ambiguous; the immediate availability of neurosurgery is under critical review, optimization of the decision-making process by an in-house trauma surgeon in the early stages of trauma resuscitation and care is often not practiced, and controversy exists regarding the impact of treating a certain volume of trauma patients per year. In this country, trauma centers are not required to undergo formal accreditation procedures and a large number of facilities that are not designated as Level I trauma centers provide all or almost all of the services required for this designation.

The preferred location for primary evacuation should be governed by the condition of the patient and each facility's distance from the location of the event. Deterioration into the vicious cycle of hypothermia, acidosis and coagulopathy with resultant microcirculatory failure is time dependent. Both damage control surgery and non-operative treatment can be provided in either Level I or Level II trauma centers. If the former is relatively distant, extending transport time is not only unjustified but potentially damaging. Elimination of non-Level I facilities from the management sequence of the trauma patient is counterproductive to patient therapy as it destroys the concept of the trauma system in favor of the trauma center. A paradigm shift should be made in the concept of trauma care to redefine the trauma center as a team player, part of the trauma care system working in cooperation with hospitals to improve trauma care.

References

1. Bureau of Health Services Resources. Division of Trauma and Emergency Medical Services: Model Trauma Care System Plan. Health Resources and Services Administration. Rockville, MD: United States Department of Health & Human Services, 1992.
2. American College of Surgeons Committee on Trauma. Resources for Optimal Care of the Injured Patient. Chicago: American College of Surgeons, 1999.
3. Esposito TJ, Kuby AM, Unfred C, et al. National Survey of Surgeons on Trauma Care Issues. Newark, NJ: Robert Wood Johnson Foundation Report, 1993.
4. Esposito TJ, Reed RL 2nd, Gamelli RL, Luchette FA. Neurosurgical coverage: essential, desired, or irrelevant for good patient care and trauma center status. Ann Surg 2005;242(3):364–70; discussion 370–4.
5. Porter JM, Ursic C. Trauma attending in the resuscitation room: does it affect outcome? Am Surg 2001;67(7):611–14..
6. Helling TS, Nelson PW, Shook JW, Lainhart K, Kintigh D. The presence of in-house attending trauma surgeons does not improve management or outcome of critically injured patients. J Trauma 2003;55(1):20–5.
7. Fulda GJ, Tinkoff GH, Giberson F, Rhodes M. In-house trauma surgeons do not decrease mortality in a level I trauma center. Trauma 2002;53(3):494–500; discussion 500–2.
8. Smith RF, Frateschi L, Sloan EP, et al. The impact of volume on outcome in seriously injured trauma patients: two year's experience of the Chicago trauma system. J Trauma 1990;30:1066–76.
9. Konvolinka CW, Copes WS, Sacco WJ. Institution and per-surgeon volume versus survival outcome in Pennsylvania's trauma centers. Am J Surg 1995;170:333–40.
10. Glance LG The relation between trauma center outcome and volume in the National Trauma Databank. J Trauma 2004;56(3):682–90.
11. Helling TS, Morse G, McNabney WK, et al. Treatment of liver injuries at level I and level II centers in a multi-institutional metropolitan trauma system. The Midwest Trauma Society Liver Trauma Study Group. J Trauma 1997;42(6):1091–6.
12. Trunkey DD. History and development of trauma care in the United States. Clin Orthop Relat Res 2000;(374):36–46.
13. Peitzman AB, Courcoulas AP, Stinson C, Udekwu AO, Billiar TR, Harbrecht BG. Trauma center maturation. Quantification of process and outcome. Ann Surg 1999;230:87–94.
14. Peleg K, Aharonson-Daniel L. Road traffic accident severe injuries. Decision-making on the basis of partial data. Harefuah 2004;143(2):111–15,167,166 (Hebrew).
15. Demitriades D. The effect of trauma center designation and trauma volume on outcome in specific severe injuries. Ann Surg 2005;242(4):512–17; discussion 517–19.
16. Clancy TV. A statewide analysis of level I and II trauma centers for patients with major injuries. J Trauma 2001;51(2):346–51.
17. Lucas CE, Buechter KJ, Coscia RL, et al. The effect of trauma program registry on reported mortality rates. J Trauma 2001;51(6):1122–6; discussion 1126–7.
18. Demetriades D. Trauma deaths in a mature urban trauma system: is "trimodal" distribution a valid concept? J Am Coll Surg 2005;201(3):343–8.
19. Demetriades D. Paramedic vs. private transportation of trauma patients. Effect on outcome. Arch Surg 1996;131(2):133–8.
20. Martin RS. Injury-associated hypothermia: an analysis of the 2004 National Trauma Data Bank. Shock 2005;24(2):114–18.
21. Schreiber MA. Damage control surgery. Crit Care Clin 2004;20(1):101–18.
22. Hawkins ML, Wynn JJ, Schmacht DC, Medeiros RS, Gadacz TR. Nonoperative management of liver and/or splenic injuries: effect on resident surgical experience. Am Surg 1998;64(6):552–6; discussion 556–7.
23. Harbrecht BG, Zenati MS, Ochoa JB, et al. Management of adult blunt splenic injuries: comparison between level I and level II trauma centers. J Am Coll Surg 2004;198(2):232–9
24. Somasundar PS, Mucha P, McFadden DW. The evolving management of blunt hepatic trauma in a rural setting. Am Surg 2004;70(1):45–8.

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There is no need for temples, no need for complicated philosophy. Our own brain our own heart is our temple; the philosophy is kindness.

Dalai Lama