Abstract:
The concept of a “golden hour” is a fixture in trauma care. There is a dearth of scientific proof for this concept but an abundance of controversy around how this concept should be interpreted, especially for pediatric trauma patients. Health care providers should instead focus on the “golden opportunity,” different for each patient, to provide the best care in the most appropriate environment for all injured children.

Keywords:
pediatric trauma; golden hour; pediatric emergency; trauma systems; interfacility transport
THE GOLDEN HOUR

The term golden hour is a fixture in the lexicon of trauma care. The phrase refers to a critical period in the care of trauma patients during which appropriate care may limit morbidity and increase survival. The origin of this term is difficult to trace. It may have evolved from an early description of the relationship between survival and time from injury to treatment on the battlefields of World War I. This analysis of French military data showed a decrease in mortality from battle wounds from 10% within 1 hour of treatment to 75% at 8 hours post-injury. More recent medical literature often attributes the phrase “golden hour” to trauma surgeon R. Adams Cowley, MD, one of the early champions of organized trauma care. Dr Cowley conducted trauma research and wrote and spoke extensively on the subject of trauma care, and the coining of the term golden hour is often attributed to his speeches, yet none of his publications mentions or tests the theory of a golden hour in trauma care. Modern support for the golden hour concept began in the 1960s when trauma care in the United States was in its infancy and civilian trauma systems were nonexistent. Military data from each of the world wars, the Korean Conflict and the war in Vietnam, show decreased combat mortality with the development of faster, more organized systems for the transport of injured troops from the battlefield to medical care facilities. This increased survival was attributed in part to faster evacuation of wounded soldiers from the battlefield to the hospital by way of helicopter transport. The 1960s and 1970s saw an increased interest in civilian trauma care. Federal legislation led the way for funding emergency medical services (EMS) standards and training. The American College of Surgeons published the first of many guidelines for trauma care in 1976. Pioneers such as Dr Cowley championed trauma care as a specialty with its roots in general surgery. Helicopter transport began to be seen as a means of quickly moving injured patients to hospitals; some hospitals began to devote specialized resources and teams to care for trauma victims, and the concept of regionalized trauma systems gained support from health care providers and governing bodies.

TRAUMA SYSTEMS AND TRANSPORT TO TRAUMA CENTERS

Early studies of trauma patients appeared to show increased survival with the development of these early trauma systems and continue to show improved outcomes for severely injured patients cared for in dedicated trauma centers. A core principal in many of these systems is the belief that critically injured patients are best cared for in designated trauma centers, even if transport from the field to these centers bypasses closer medical facilities. The combination of the concepts of the golden hour and the importance of trauma centers has been the impetus for the development of EMS policies such as rapid scene triage, minimization of on-scene treatment interventions in favor of rapid transport to emergency departments, and air evacuation of severely injured patients directly from the site of injury to designated trauma centers. These practices are not without cost, in money for equipment and staffing of helicopter transport and EMS resources. They are also not without risk to EMS teams, patients, and bystanders when priority is placed on rapid transport, sometimes across great distances. A common debate in trauma system development centers on whether patients should be transferred longer distances to trauma centers or to the closest available facility, where initial stabilization may be performed, and then those patients determined to need further specialty care are then transferred to a trauma center. Much of the current literature supports a varied approach based on geographic location. In urban areas, where level I trauma centers are often readily available, it may make sense to bypass closer facilities to reach the trauma facility, as differences in transport times are likely to be minor. In rural areas, however, transport times to trauma centers may be prolonged, and patients may benefit from stabilization in a closer facility followed by transfer to a trauma center after initial stabilization. Effective trauma systems must therefore take into account the location and capabilities of the facilities within a geographic catchment area, as well as any traffic or geographical features that may impact transport times. This approach to establishing effective trauma systems is perhaps best characterized by the “3R” rule attributed to pioneering trauma surgeon Dr Donald Trunkey of getting the “right patient to the right place at the right time.” Some patients may have only minutes to survive without appropriate intervention, whereas some may survive their initial injuries but need specialized care and rehabilitation to achieve maximum post-injury function. This concept might well be the best guiding principle of trauma management, and the immediate postinjury period might best be thought of as a “golden opportunity” to ensure prompt, appropriate treatment for each and every injured patient.
If the concept of a golden hour and its relationship to trauma systems is controversial and unproven in adults, it is even more so for pediatric trauma patients. The development of pediatric emergency medicine as a specialty has promoted the creation of pediatric trauma centers, some as part of free-standing children’s hospitals and others within general/adult facilities. Pediatric trauma care continues to evolve as a distinct facet of trauma care that recognizes the different anatomical, physiological, and developmental realities of pediatric patients as well as the different injury patterns seen in these patients. The development and concentration of pediatric expertise has improved the management of injured children, with patients cared for in pediatric trauma centers appearing to have equal or better outcomes overall when compared to pediatric patients cared for in general or adult trauma centers.11-17 Many factors likely contribute to this positive effect including the availability of appropriately sized equipment and monitoring capabilities for pediatric patients, health care providers capable of recognizing and treating the early, often subtle, signs of shock in pediatric patients, and management strategies unique to pediatric injuries.

Despite evidence to suggest better outcomes for pediatric trauma victims treated in pediatric trauma centers, most pediatric trauma victims are cared for, at least initially, in nonpediatric centers, as the number and geographic location of dedicated pediatric centers leaves many children out of reach for immediate care.12,13 The question that therefore arises is not only does a golden hour exist for the treatment of pediatric trauma patients, but also, what should occur during that initial time frame. One aspect of this debate centers on whether pediatric trauma patients should be transported directly to pediatric centers, possibly bypassing other emergency facilities or trauma centers on the way to specialized pediatric care, or should they be stabilized at the closest capable facility and then transferred to specialized pediatric centers if their condition warrants. It is worrisome that pediatric patients may be subjected to longer transport times, possibly bypassing “adult” trauma facilities to reach pediatric centers, as EMS providers often do not have great familiarity or experience with critically ill or injured children. The EMS pediatric volumes are often quoted as around 10% of EMS calls, with less than 1% of these patients meeting the definition of critically ill. The EMS personnel may have difficulty performing procedures such as intravenous access, endotracheal intubation, and appropriate cardiopulmonary resuscitation on pediatric patients.14,15 There is literature to suggest similar outcomes for pediatric patients ventilated by means of bagging instead of endotracheal intubation in cases of respiratory failure, suggesting that intubation should not be attempted in the field for pediatric patients in urban locations where transport times to hospital emergency departments is fairly short.15

Another study examining the effectiveness of pediatric helicopter transport showed no benefit for patients transported directly from the scene of injury to a pediatric trauma center as compared with those initially stabilized at the closest medical facility.17 All of this information could be interpreted that time spent in EMS transport of critically ill and injured children should be minimized, and these patients should be transported to the closest facility able to provide stabilizing, if not definitive, care.

If pediatric patients are to be transported to non-pediatric-specific hospitals, the emergency departments at these facilities must be capable of assessing pediatric trauma patients and providing stabilizing care (also see article “Pediatric Patients in the Adult Trauma Bay—Comfort Level and Challenges,” in this issue). Although most emergency department visits in the United States involving children occur in nonpediatric facilities, many of these facilities are underprepared to deal with critically ill or injured children. In 2001, the American Academy of Pediatrics and the American College of Emergency Physicians established a set of guidelines for pediatric emergency department preparedness.18 These guidelines, which were recently updated in 2009, address equipment, training, and quality review for pediatric care in emergency departments.19,21 Surveys evaluating preparedness continue to show inadequate preparation in equipment and training for pediatric patients.13,20,22 Nonpediatric centers often transfer seriously ill or injured patients to pediatric centers for definitive care. The presence of a seriously injured child may engender a sense of anxiety in the emergency department and has the potential to create a stress-laden atmosphere in which recognition and treatment of life-threatening shock and respiratory failure go unaddressed and untreated in attempts to get the patient out of the facility and enroute to a pediatric center.

**PEDIATRIC TRAUMA AND TRAUMA CENTERS**

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**EMERGENCY DEPARTMENT READINESS FOR CHILDREN**

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specialty center as quickly as possible. Missed injuries on an initial trauma survey are a common problem, and there is some evidence from adult studies that seriously injured patients transferred from rural hospitals to trauma centers frequently have unrecognized injuries.23,24 This suggests that patients may have injuries overlooked in favor of rapid transport to a trauma center. This problem may be even more widespread for pediatric patients in similar situations. Recent literature supports early recognition and treatment of shock and respiratory failure as important in improving ultimate survival and outcome of critically ill or injured patients, both adult and pediatric.25,26 Similarly, neurologic outcome has been shown to improve with early appropriate resuscitation and monitoring of children with traumatic brain injury.27 Unfortunately, studies of pediatric patients transferred to pediatric centers describe deficiencies in the detection and treatment of shock, hypotension, and respiratory failure before transfer.18,25,26

INITIAL STABILIZATION OF INJURED CHILDREN

So what should be the scope of the evaluation and stabilization of pediatric trauma patients in general trauma facilities or community hospitals? A primary survey focusing on airway, breathing, and circulation should be undertaken and any life-threatening conditions corrected. All patients should be placed on supplemental oxygen. Advanced airway management in the form of endotracheal intubation may be needed in patients with severe traumatic brain injury, thoracic injuries, or shock. Adequate oxygenation and ventilation should be ensured. A portable chest radiograph to evaluate for pneumothorax may be helpful. Placement of a thoracostomy tube should be pursued for most cases of pneumothorax. Close attention should be paid to the child's hemodynamic status. Health care providers must keep in mind that the strong compensatory mechanisms in children and teenagers allow them to increase their systemic vascular resistance and maintain blood pressure until a substantial amount of blood is lost.19,28 Early signs of shock such as tachycardia, mental status, and capillary refill time are more sensitive and should be monitored closely. An initial fluid bolus of isotonic saline should be administered and repeated as needed. Blood component transfusion should be considered for patients not responding to crystalloid resuscitation or for those with evidence of ongoing hemorrhage.27 Patients with immediately life-threatening hemorrhage would seem to be candidates for immediate transfer to a trauma center with pediatric surgeons and a pediatric intensive care unit but at times may require the services of a general surgeon, if available, to control hemorrhage before transport. Most pediatric trauma is caused by blunt mechanism of injury such as falls, motor vehicle collisions, assault, and sporting activities. Most patients will not require emergent surgical intervention. Pediatric trauma specialists have led the development of protocols for expectant, nonoperative management of some conditions, namely liver and splenic injuries. In adult-oriented systems, these injuries are generally treated surgically, whereas children cared for in pediatric centers are usually managed nonoperatively. Therefore, pediatric patients undergo fewer laparotomies and splenectomies than do adult patients.29,30 The golden hour for these patients might best be spent ensuring adequate oxygenation and ventilation, securing an airway if needed, obtaining vascular access, and providing initial fluid resuscitation if needed. Patients with traumatic brain injury must be carefully monitored, and hypotension and hypoxia avoided as both of these states have been found to be independent predictors of increased mortality in patients with traumatic brain injury. Pediatric patients with isolated brain injuries may best be stabilized at the closest medical facility in which these conditions may be recognized and corrected as needed. Transport could then be undertaken in a controlled fashion and preferably with a specialized pediatric critical care transport team. Time should not be spent obtaining computerized tomography and other extensive imaging studies if the facility lacks the surgical capabilities to provide definitive care for injuries detected on imaging or if obtaining scans will delay transport. Scans may inadvertently fail to be transported with the patient or, in the case of digital images, transferred by compact disk, inaccessible at the receiving facility, thus, necessitating repeat imaging with increased costs and unnecessary radiation exposure to the patient. In fact, one study found that almost all radiographs performed at referring facilities were later repeated when patients arrived to the trauma center.31

Once critically ill or injured children are stabilized and the decision is made to transfer to a pediatric trauma center, attention must then be turned to the best mode of transfer. One recent study showed significantly more complications and deaths (23% mortality vs 9% mortality) among pediatric patients transferred from referring facilities to a pediatric trauma center by “general” helicopter teams vs specialized pediatric teams.
This remained true even when corrected for patient mix and the greater average time from referral to arrival in the pediatric center among patients transported by the specialty teams. The authors speculate that despite overall longer transport times, the patients transported by the specialized team actually benefited from an overall longer period in the care of pediatric specialists. This concept of “bringing the hospital to the patient” may in fact be a critical piece of care that is currently lacking in many trauma systems. Several studies have shown that transport by specialty-trained “mobile intensive care unit” teams is associated with improved outcomes, even if such transport delays ultimate patient arrival at the tertiary care center.

THE GOLDEN OPPORTUNITY

So what is the best care for pediatric trauma patients? How can a system capitalize on the “golden opportunity” to provide the right care in the right place at the right time? Creation of regionalized trauma systems to ensure timely access to basic evaluation and stabilization for all patients is vital. This may require initial transport of pediatric trauma patients to general emergency facilities, especially in rural areas without immediately available pediatric trauma centers. These facilities must be capable of evaluating and stabilizing pediatric trauma patients. Appropriately sized equipment and monitoring capabilities must be present. Staff must have skills in the assessment and stabilization of pediatric patients, especially in the management of shock and real or impending respiratory failure. Pediatric patients with severe or life-threatening injuries, especially those in need of intensive care unit-level care, should then be transferred to appropriate pediatric trauma facilities as rapidly as possible after initial stabilization of any immediately life-threatening conditions. The criteria for transfer and mechanisms for referral and transfer must be put in place and maintained. Transfer agreements between general and pediatric trauma centers must be well designed with prompt, easily accessed communication readily available between facilities to expedite transfers. Careful consideration should be given to the mode of transfer and composition of the transport team. For many pediatric patients, this may mean awaiting the arrival of specialized transport teams from the receiving institution. In these situations, personnel at the referring facility must be capable and remain committed to caring for the patient until the team arrives. They must adopt a mentality of ongoing treatment vs “awaiting transfer” and be capable of recognizing and responding to evolving clinical changes in pediatric patients.

SUMMARY

Certainly, no one would argue that timely care is best for critically ill and injured persons. However, the exact meaning and significance of a golden hour in trauma care is the subject of debate and controversy. So is there a golden hour? If there is, then what should occur during this time? Should this time be spent transferring a patient from the scene to a major trauma center, even if it is not the closest facility? Or should patients be stabilized at the closest medical facility before transfer? Furthermore, how do the concepts of a golden hour and trauma system care apply to pediatric patients? Perhaps, the answers lie somewhere in between, and rather than a golden hour, health care providers should focus on the “golden opportunity” to provide stabilization of immediately life-threatening conditions at the closest appropriate facility followed by safe transfer when needed for definitive care. True realization of this opportunity for pediatric trauma patients requires individualized consideration for each patient within well-established and well-coordinated systems of regionalized trauma care.

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