Analysis of Compliance and Outcomes in a Trauma System With a 2-Hour Transfer Rule

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Hypothesis: Minimizing time to definitive care in an effort to optimize outcomes is the goal of trauma systems. Toward this end, some systems have imposed standards on time to interfacility transfer. This study evaluates compliance and outcome in a system with a 2-hour transfer rule.

Design: Retrospective review.

Setting: State trauma registry data from 1999 to 2003.

Patients: Trauma patients who underwent interfacility transfer and those who did not.

Main Outcome Measures: Time to transfer; Injury Severity Score; mortality; and time to operating room at second facility. These variables were then stratified by time to transfer.

Results: During the study period, there were 22,447 interfacility transfers. Overall transfer rate was 10.4%. Of the transfers, 4,502 (20%) occurred within 2 hours. Median transfer time was 2 hours 21 minutes. Injury Severity Score, mortality, and number of patients with operation performed on same day of transfer were all higher for the group transferred within 2 hours in comparison with patients transferred on the same day of injury at greater than 2 hours.

Conclusions: While the majority of transfers occur at greater than the mandated 2-hour interval, the most seriously injured patients are reaching definitive care within 2 hours. Markers of acuity for patients transferred at greater than 2 hours parallel those of the general trauma patient population. These data suggest that, in this system, provider-determined transfer time that exceeds 2 hours has no adverse effect on patient outcome. It appears to accomplish recognition and rapid transport of the most seriously ill. This may obviate the need for onerous system mandates that are not feasible or have poor compliance.

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TRAUMA SYSTEMS HAVE BEEN designed to optimize the outcomes of injured patients by encouraging providers to triage patients to appropriate levels of care, defining prehospital and interhospital transport patterns, and educating caregivers in the recognition of actual and potentially life-threatening injuries that may exceed the capabilities of local resources and require transfer for definitive care. These strategies have consistently demonstrated a survival benefit. Long delays in the transfer of injured patients to higher levels of care are felt to be undesirable and associated with suboptimal outcomes. This has been shown to be the case particularly in rural trauma centers. However, when stabilization can be achieved at the hospital providing emergent care, time to transfer does not appear to impact survival, while Injury Severity Score (ISS) strongly predicts mortality. This finding has also been demonstrated in urban trauma centers. A study from the University of Washington found no impact of transfer time on mortality, although care costs were higher. The cost difference was ascribed to the higher injury severity of the transferred patients.

Transfer practices may generate a certain degree of overtriage, or, in the case of nontransfer, a degree of undertriage. Overtriage occurs when patient needs can actually be met at the referring facility. Transfer from those facilities, if excessive, can potentially overburden the receiving trauma centers. If nonmedical factors, such as patient payer status, enter into transfer decisions, this may also adversely affect the recipient centers. Emergency Medical Treatment and Active Labor Act (EMTALA) policies have sought to limit these occurrences. There have been a variety of studies examining this issue that have generated conflicting findings with regard to the degree and effect of these types of transfers.
The Illinois state trauma system defines in statute a 2-hour interhospital transfer window in an effort to assure expeditious transfer of patients and provision of definitive care in a timely fashion. Transfer criteria are not well described, however, and deviation from this practice has been observed. This study was undertaken to evaluate compliance with a 2-hour transfer rule in a mature trauma system and to characterize patient profiles of severity and outcomes stratified by compliance. It also seeks to characterize severity profiles for patients transferred at less than and at greater than 2 hours. Lastly, it attempts to determine whether compliance or noncompliance with the rule have any effect on patient outcome.

**METHODS**

The Illinois State Trauma Registry (ISTR) includes data from 64 designated trauma centers housed at 62 hospitals in Illinois. There are 13 level I adult centers and 45 level II adult centers; 2 hospitals are both level I adult and pediatric centers and 2 hospitals are pediatric trauma centers only. There is no level III or level IV designation in the state system. All designated trauma centers are required to submit data to the ISTR on all patients meeting entry criteria. The Illinois Department of Public Health maintains this registry and is the standard-setting and designating agency for the state trauma system.

Institutional review board exemptions were obtained from the authors’ institutions and a retrospective review of trauma patient transfers was performed. The ISTR data from 1999 through 2003 were reviewed. Specific data included injury date and time, transfer date and time, Abbreviated Injury Score (AIS), primary International Classification of Diseases, Ninth Revision (ICD-9) code, ISS, demographic variables, time to operative intervention, and mortality. Time to transfer was calculated from the injury and transfer date and time variables. Three groups were used for comparison, all trauma patients, patients transferred to another institution on the same day of injury at greater than 2 hours, and patients transferred within 2 hours of arrival after injury. Statistical significance of differences between groups was determined using $\chi^2$ tests at $P$ less than .05. Finally, multivariate logistic regression analysis was used to determine the effects of trauma transfer on mortality.

During the study period, there were 22,447 interfacility transfers. Information about time to transfer was available in 50% to 60% of cases per year. There was no difference in demographic or acuity characteristics between the study group and excluded cases. Overall transfer rate was 10.4%. There was a trend over the study period of an increasing proportion of transfers (Figure 1). By 2003, more than 12% of patients experienced an interfacility transfer; the majority of transferred patients had a blunt mechanism of injury (>98% yearly). Of the transfers, only 20% (502) occurred within 2 hours, with a range of minutes to weeks. Median transfer time was relatively constant over the 5-year study period, approximately 2 hours 20 minutes.

The ISS was higher for all transferred patients and significantly higher for patients transferred within 2 hours of arrival for all years studied (Figure 2). The proportion of patients who underwent surgery on the day of transfer was also higher for the group transferred within 2 hours in comparison with all trauma patients who underwent an operation at any time during hospitalization and patients transferred on the same day of injury at greater than 2 hours (Figure 3).

Patients with head injuries or orthopedic injuries were the most commonly transferred (Figure 4). Mean AIS for head injuries and orthopedic injuries were for the most part higher in patients transferred in the first 2 hours (Figure 5 and Figure 6). Craniotomies and craniectomies were much more common among patients transferred within the first 2 hours, though less than half of these procedures took place on the day of transfer for any given year. Orthopedic, vascular, abdominal, and thoracic procedures were not more
common among patients transferred than the rest of the trauma population for any year studied.

In general, the proportion of self-pay patients was greater among patients transferred within the first 2 hours in comparison with other same-day transfers or all trauma patients (Figure 7). Finally, unadjusted mortality was higher each year for patients transferred within the first 2 hours. Patients undergoing transfer after the first 2 hours demonstrated mortality rates similar to all trauma patients entered into the registry (Figure 8).

Logistic regression models controlling for head AIS, ISS, age, gender, and hypotension on arrival were performed to compare mortality between patients in the early-transfer group with the rest of the trauma population. When controlling for severity of injury, mortality differences were not evident. A second set of regressions included transfer status as a variable, and this analysis did not demonstrate a significant deleterious effect of transfer time on mortality.

**COMMENT**

This study demonstrates that in a state trauma system where transfer of patients thought to require a higher level of care is mandated to occur within 2 hours, the majority of transfers do not comply with this time standard. Despite this, the most seriously injured patients do appear to be reaching definitive care within that 2-hour time frame. Using mortality, ISS, and surgery on the day of transfer as proxies for injury severity and need for rapid transfer to a higher level of care, the group transferred within 2 hours had consistently higher values for each of these variables when compared with all trauma patients and the group transferred at greater than 2 hours. This corroborates the contention that these are the more critically ill patients in need of more rapid transfer. Furthermore, logistic regression analysis shows that mortality is associated with underlying injury severity more so than transfer time. That finding notwithstanding, patients with severe illness seem to be recognized by providers in this system in a timely and appropriate fashion irrespective of state system mandates.

While this data set does not provide cause of death for patients, national data show head injury to be the leading cause of injury mortality. The higher head AIS and number of intracranial procedures performed on the early-transfer group suggest that this etiology may account for a large part of the deaths in this study as well.

Although there are not sufficient data from the ISTR to prove this, it is surmised that delays are related to late diagnosis of injuries (eg, a patient with head injury with a normal Glasgow Coma Scale score taking longer to get a head computed tomographic scan and then being diagnosed with traumatic lesion) or the time related to locating and determining whether a specialty provider, such as an orthopedist or neurosurgeon, is willing to treat the patient locally. The data also suggest that in this system, provider-determined transfer times that exceed this mandated interval have no adverse effect on patient outcome. This is shown by the logistic regression results and the fact that there is no statistical difference in any of the severity indicators examined between patients transferred at greater than 2 hours and all trauma patients. Therefore, it seems that initial caretakers do seem capable of recognizing and accomplishing rapid transport of the most severely injured without system rules. In an era of increasing regulation, this may provide evidence that onerous system mandates that are not feasible and have a poor compliance rate are unnecessary. Such policies and regulations may be of no tangible benefit to patient outcomes and heighten the potential risk of medicolegal ramifications associated with noncompliance. They thereby may also create another argument for refusal of providers to treat trauma patients.
eral increase in these types of patients entering the trauma center system. This is disproportionately high in relation to the general population of trauma patients as one might expect. This finding, along with that of an increasingly disproportionate rate of orthopedic and neurosurgical transfers, speaks to a growing reluctance to treat patients with any severity of these injuries despite the theoretical capabilities to do so at the level II centers.

Additionally, the proportion of self-pay patients in the group transferred at less than 2 hours was consistently higher than in the other 2 study groups. However, this proportional difference in self-pay patients between groups decreased over the study period, perhaps reflecting a positive effect of EMTALA legislation.

The implications of this analysis for system planners and managers may be that greater emphasis should be placed on regulations or mandates pertaining to indications for transfer (or nontransfer) rather than on time to transfer. This may have greater benefits to patients and system efficiency and costs by reducing unnecessary transfers and the burden on level I centers.

There are several limitations to this study. The data in the ISTR are not well controlled for quality. Wide variability in accuracy, completeness, and consistency of data recording at the local level is assumed to exist. In this analysis, appropriate information was available on only half of cases in the registry, and nonrandom patterns of missing data cannot be excluded. These findings are from a single state and may not be able to be extrapolated to other states or systems where resources and other factors may differ significantly.

Additionally, trauma registry data also do not allow the acquisition of appropriate information on other interventions at the receiving facility, such as intubation, chest tube insertion, blood transfusion, angiography, or dialysis, to comment accurately on their performance. While relevant, we do not feel these are markers of acuity nor are they interventions that are unavailable at level II trauma centers.

Finally, the difference between statistically significant, vs clinically significant, findings is always of interest and importance. Small differences in mortality and other indicators of severity in this study are felt to be clini-
Time to Transfer May Not Matter, or Does It?

Crandall et al have reviewed the ISTR, concluding that provider-determined transfer time exceeding the state-mandated 2 hours does not worsen outcome. Only 20% of the transfers occurred within 2 hours, but median transfer time was less than 2.5 hours, so half of the patients met the spirit of the regulation.

We have known that injury is a time-related disease since R. Adams Cowley defined the Golden Hour. Patients with traumatic brain injury (TBI) were among the most commonly transferred. Operative therapy for TBI was more common among patients transferred within 2 hours but often did not occur immediately. We get no information about intracranial pressure monitoring, treating intracranial hypertension, or long-term outcomes after TBI. Early transfer and expeditious nonoperative care may be as important as early operation after TBI.

Patients with multiple long bone fractures also benefit from early transfer. Data from our institution’s large population studied, yearly trends that demonstrate a sustained and increased mortality for the early transfer group are felt to substantiate a case for clinical relevance, which is notable.

In summary, this study of 1 state trauma system suggests that there is poor compliance with a mandated 2-hour transfer window but that the most severely injured patients are being recognized early and transferred within that standard interval. It also may be that time to transfer is less influential on mortality than is injury severity. Of greater note may be the nature of transfers from level II to level I centers that appear to be predicated on factors unrelated to injury severity and associated with a perceived reluctance to treat locally. Regulation of transfer indications, rather than the time to transfer, may be more beneficial to the system as a whole.

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REFERENCES