Isolated Transient Loss of Consciousness Is an Indicator of Significant Injury

John T. Owings, MD; David H. Wisner, MD; Felix D. Battistella, MD; Jon Perlstein, MD; William F. Walby, MS; R. Steven Tharratt, MD

Objective: To determine if isolated transient loss of consciousness is an indicator of significant injury.

Setting: University-based level I trauma center.

Design and Patients: Phase 1 retrospective case series of all patients with trauma admitted directly from the emergency department to the operating room or an intensive care unit who had transient loss of consciousness as their only trauma triage criterion. Phase 2 prospective case series of all trauma patients transported by emergency medical system personnel with transient loss of consciousness as their only trauma triage criterion.

Main Outcome Measures: Emergency operation and intensive care unit admission.

Results: Phase 1: From January 1, 1992, to March 31, 1995, we admitted 10,255 patients with trauma. Three hundred (3%) met the enrollment criteria and were admitted to the operating room (n = 168) or intensive care unit (n = 139). Of these, 58 (18.9%) were taken to the operating room emergently to manage life-threatening injuries: 11 (4%) had craniotomies and 47 (15%) had non-neurosurgical operations. Phase 2: From July 1 to December 31, 1996, 2,770 trauma patients were transported to our facility; 135 (4.9%) met the enrollment criteria. Forty-one (30.4%) of these required admission, and 6 (4.4%) were taken emergently to the operating room from the emergency department (1 [1%] for a craniotomy, 3 [2.2%] for intra-abdominal bleeding, and 2 [1.5%] for other procedures). Two (1.5%) of the 135 patients died.

Conclusions: Patients with isolated transient loss of consciousness are at significant risk of critical surgical and neurosurgical injuries. These patients should be triaged to trauma centers or hospitals with adequate imaging, surgical, and neurosurgical resources.

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Since the late 1970s, the concept of concentrating resources and skills in trauma centers to facilitate optimal care of injured patients has become well accepted in the United States. West et al demonstrated that victims of blunt trauma who were cared for in a hospital designated and prepared to receive all local trauma cases were less likely to suffer a preventable death than patients with similar injuries cared for in hospitals not specifically organized to provide trauma care. Although the trauma center concept has been generally accepted since that article, which patients should be taken to trauma centers remains the subject of controversy.

Trauma triage criteria are established a priori in a manner that allows emergency medical system (EMS) field personnel to rapidly identify patients who need to be transported to a trauma center. The criteria are intended to identify those patients who would benefit from the resources of a trauma center or, more important, potentially be harmed by the absence of resources at a hospital not designated as a trauma center.

Unfortunately, there has not been uniform agreement on what characteristics should be used as trauma triage criteria. Some states (eg, Illinois) have established specific criteria for both trauma center designation and patient triage. Other states (eg, California) have given their counties the responsibility for establishing triage criteria. The American College of Surgeons has published extensive reports on the system resources required to provide optimal care to injured patients and suggested trauma triage criteria. These different groups agree on many triage criteria, but on a number, they conflict.

The trauma triage criteria of Sacramento, Calif, mirrored the American College of Surgeon's criteria relatively closely. Our region included physiological, ana-
PATIENTS AND METHODS

Our study was conducted in 2 phases at the University of California, Davis, Medical Center, a level 1 trauma center. The first phase was a retrospective review of patients admitted to our trauma center with isolated transient LOC. The second phase was a prospective audit of all patients in our county with isolated transient LOC who were transported by the EMS to our trauma center.

The primary and secondary end points of both phases of our study were the same and were based on the use of services available at trauma centers that may not be immediately available at hospitals not designated to receive trauma cases. The primary end point was the need for an emergency surgical or neurosurgical procedure. The operation was defined as being an emergency if the underlying condition would be immediately life- or limb-threatening in the absence of an operative intervention (ie, epidural hematoma). The procedure was defined as urgent but not an emergency if it was necessary to accomplish it promptly (ie, open fracture). The secondary end point of the study was admission to an intensive care unit (ICU).

PHASE 1

Phase 1 was a retrospective review of all patients transported to our level 1 trauma center during a 39-month interval. The trauma registry was reviewed for all patients triaged based solely on LOC. From these patients, we identified and included only those whose LOC was transient. Transient LOC was defined as LOC followed by the return of mental function to a Glasgow Coma Scale score of 14 or 15 on arrival to the emergency department (ED). To determine if serious injuries were present in this group, we further limited the review to those persons who were admitted directly to the operating room (OR) or an ICU. Medical records of patients meeting the above criteria were individually reviewed. Each operative record was reviewed by a single senior trauma surgeon (D.H.W.). Operations were classified as either neurosurgical or nonneurosurgical. Operations were further classified as an emergency or as urgent. Admissions to an ICU were classified as due to head injury (eg, monitoring of significant head injury), or other (eg, placement of a thoracic epidural catheter for rib fractures in an elderly person). Demographic data, mechanism of injury, and outcome of patients were also reviewed and recorded.

PHASE 2

Phase 2 was a prospective study of all trauma patients in our EMS region who had isolated transient LOC. Although isolated transient LOC was dropped as a formal trauma triage criterion at the beginning of this phase, to validate the findings of our retrospective analysis, we continued to have all patients with isolated transient LOC transported to our facility. Between July 1, and December 31, 1996, EMS personnel transporting a patient with transient LOC to our trauma center were required to contact the medical control physician contemporaneously and identify the patient. These patients were then observed for disposition from the ED (OR, ICU, ward, or home), demographics, and outcome.

In the retrospective phase of the study, the Injury Severity Score was calculated based on International Classification of Diseases, Ninth Revision, Clinical Modification codes using a computer software package (ICDMAP-90 Software, Tri-Analytics, Inc, Bel Air, Md). In the prospective study, the Injury Severity Score measurements were calculated based on the 1990 modification of the 1988 injury scoring system. The prospective demographic data are presented only for patients who were admitted to the hospital.
agency. Of these, 135 (4.9%) patients had transient LOC and no other identifiable criterion for transportation to a trauma center. The immediate disposition from the ED of these patients is shown in Table 1. A head computed tomographic scan was done in 93 (68.8%) patients, and in 23 (17%) the scan revealed abnormalities.

Of the original 135 phase 2 patients, 41 (30.4%) required admission to the hospital. All patients with abnormalities on a head computed tomographic scan were admitted. The admitted patients were the focus of this phase of our study. In addition to the 4 patients listed in Table 1 as having an ICU disposition, 2 patients who were initially taken to the OR also required ICU admission, so the total admitted to an ICU was 6. All patients admitted to an ICU in this phase were admitted because of head injury. The patients’ mechanisms of injury, demographic data, and indications for emergency operation are given in Tables 2, 3, and 4, respectively. The 1 patient listed in Table 4 as having an “other neurosurgical” operation underwent elevation of a depressed skull fracture, and the patient listed as having “other nonneurosurgical” had repair of facial fractures.

Two (1.5%) of the patients in phase 2 died, both as a result of head injuries. The first of these was an 87-year-old man who had progressive cerebral edema due to an intraparenchymal hemorrhage suffered in a fall from a bicycle. The second was a 64-year-old man who was the victim of an assault in which he suffered multiple intraparenchymal hemorrhages. The hemorrhages rapidly progressed and resulted in a deteriorating mental status in the ED. In view of the patient’s grim prognosis, the family in consultation with the neurosurgeons decided to allow the patient to die.

The inappropriate transportation of patients who have minor injuries to trauma centers (overtriage) or transportation of patients with significant injuries to non--
trauma centers (undertriage) each have an adverse effect on patients and the trauma system as a whole. If all victims of injury were transported to a trauma center regardless of injury severity (an undertriage rate of 0%), the transportation costs would increase due to longer runs and due to the need for additional ambulances to replace those transporting victims from remote areas. In addition, the trauma center could be overwhelmed. At the other end of the spectrum, sending no patients preferentially to a trauma center (an overtriage rate of 0%), would be equally unreasonable because critical services would be unavailable to those needing them. A reasonable goal, therefore, is to optimize both undertriage and overtriage rates and, in the process, provide both optimal care and the most efficient resource use.

Fundamental to achieving the goal of optimal resource use and patient care is the establishment of prehospital criteria to identify which patients will benefit most from the services available at a trauma center. In our study, we focused on the specific criterion of isolated LOC following blunt trauma. Because our EMS region had decided to drop isolated transient LOC as a triage criterion, we sought to determine if patients with this criterion had a significant risk of major occult injury. We were particularly concerned with the frequency with which such patients would require trauma center resources, such as immediate surgical or neurosurgical intervention.

To establish the presence of significant injury in patients who sustained isolated transient LOC, we first retrospectively reviewed all patients in our trauma registry for about 3 years who had isolated transient LOC as their only trauma triage criterion. We then limited the review to only those patients who were subsequently admitted directly to the OR or an ICU. Of these patients with isolated LOC, 20% required an emergency operation for either a neurological or non-neurological injury. These patients had substantial injuries and clearly benefited from the trauma center resources. They might well have suffered increased morbidity and mortality if they had not been triaged to a trauma center.

Because it was most efficient for EMS personnel to record only a single trauma triage criterion, thus establishing the need for transport to the trauma center, there may have been a systematic tendency to underreport the other trauma triage criteria in this retrospectively reviewed group of patients. To remove this bias and validate our results, we conducted a prospective study of patients with isolated transient LOC.

The question we posed prospectively was, “If we exclude all those patients who might have another trauma triage criterion, are patients with a truly isolated transient LOC likely to have injuries that would require the resources of a trauma center?” In other words, should transient LOC alone be considered as a reason to take an injured patient to a trauma center? To correct for the possible underreporting of trauma triage criteria present in the retrospective portion of our study and to better establish the incidence of significant injuries in patients with isolated LOC, we prospectively recorded all patients with isolated transient LOC. Based on an agreement with the county EMS agency, EMS personnel identified patients, in the field, with transient LOC and no other criterion for triage to a trauma center. The medical control physician was contacted, and the patients were transported to our trauma center under an “other” (as opposed to “trauma”) designation and observed for outcome. In this group of 135 patients, about a third required admission. Of greater importance, a quarter of those admitted required the immediate availability of an OR, ICU, or both, and 2 others died.

Although paramedics were still required to bring patients with isolated transient LOC to our institution, it is possible that those patients who appeared minimally injured and fit no other criterion were transported to other institutions. This would represent a violation of the EMS policy at the time and clearly a protocol break. We are not aware of this happening on any significant scale, but if it had, this could bias the results of our study by overestimating the degree of injury of patients with isolated transient LOC.

We observed a significant incidence of surgical and neurosurgical injuries in both phases of our study that clearly required prompt operative intervention. An abdominal injury (ruptured spleen) was the most frequently observed single injury in both phases of our study. Even though the patients with splenic rupture proved not to have surgically correctable head injuries, they nevertheless required the rapid availability of an OR. Ruptured spleen was not only the most frequently observed injury in our study but also the most common cause of preventable death for patients not taken to a trauma center in the study by West et al. Epidural hematomas was the most frequently observed surgically correctable head injury in our study. For patients with epidural hematoma, the failure to achieve a timely evacuation of their hematomas has been well documented to result in worse outcomes. Both of these injuries have the distinct feature of a high survival rate if treatment is instituted promptly and a high mortality if treatment is delayed.

The mortality in both phases of our study was low. Other investigators have used mortality as an indicator of severity of injury to determine the accuracy of various suggested trauma triage criteria. If the validity of transient LOC was evaluated based on our recorded mortality or even the predicted mortality of our patients based on Trauma Score and Injury Severity Score (TRISS) methods, it would be considered only a low-yield triage criterion. Determinations of the validity of trauma triage criteria have been based on the outcomes of patients treated at trauma centers and presume the immediate availability of both emergency surgical consultation (neurological and general surgical) and ORs. The observed mortality in our 2 phases is based on what occurred at a trauma center with the appropriate resources available. The article that prompted the creation of trauma centers in California found a wide discrepancy between recorded survival rates at trauma centers and non–trauma center hospitals for patients with similar injuries. When injured patients were taken to hospitals that lacked the vital resources or experience they needed, patients who should have lived died. The low recorded mortality in our study underscores a best-case scenario. Had these patients been taken to a hospital without an available OR, imaging resources, or a neurosurgeon, the mortality rates may have been substantially higher.
There is nothing magical about the “trauma center” designation. Designated trauma centers, whether reviewed locally or formally verified by the American College of Surgeons, have demonstrated that they have the resources available to care for injured patients. Isolated LOC is a marker of significant injury in a substantial number of patients. As such, patients who have suffered transient LOC are at substantial risk of having an injury that will require immediate surgical or neurological intervention. Patients who suffer isolated transient LOC should be triaged to a trauma center, if one is available. If a trauma center is not available, they should be sent to hospitals with imaging capability, ORs, and surgical and neurological consultation immediately available.

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REFERENCES


DISCUSSION

David L. Gregg, MD, Menlo Park, Calif: In this era of increased involvement of corporate and government interest in the delivery of health care, it has become progressively important to base practice algorithms on data rather than our own cultural imperatives. In the field of trauma care, we need to depend on the leadership of major, nationally recognized, high-volume trauma centers to produce data that will arm us in the fight to preserve quality of care. This paper, I believe, is a fine example of such a study.

The authors have looked at a so-called low-level triage criterion, transient LOC, and have examined whether or not it is a generic marker of significant injury. In both a retrospective and prospective analysis, it clearly is. One third of their patients required hospitalization, and a significant percentage of those required immediate intensive care, surgical care, or both.

I personally would add to that number the patients who went on to have as their only operative intervention orthopedic reconstruction because, in my view, a prompt, thorough clearance of their central nervous system injury is mandatory for their safe passage through the operative event.

In my view, a hospital lacking trauma center resources cannot do this in a timely manner. I think keeping the triage criteria simple is also important to relieve the EMS personnel and to avoid confusion with subsequent error. There should be a quid pro quo, however. That mandate should be to the trauma centers to keep an eye on costs while they are evaluating such patients.

In that regard, how do you define transient LOC? Does this include patients who simply have no recollection of the event, or are these only patients who have been seen down at the scene for a period of time? I would submit that those are 2 groups of patients who perhaps could be screened out. Second, in patients who have as their only injury on primary and secondary survey the LOC, who gets a head computed tomographic (CT) scan, and can those patients be discharged from the ED without a head CT scan?

Finally, what are the criteria for admission to the ICU of a patient with a Glasgow Coma Scale score of 15? I can tell you that at Stanford, a night in the ICU is harder to get than a night in the Lincoln bedroom.

Gail T. Tominaga, MD, Honolulu, Hawaii: In the prospective phase, there were 93 patients who had head CT scans, and 23 were abnormal. What was the criteria used for obtaining a head CT scan? In the prospective phase, 41 patients were admitted. Assuming that the 23 with abnormal head CT scans were admitted and the 4 who needed surgical operations were admitted, 13 additional patients were admitted. What were the indications for admission in these 13 patients? In addition, did any patients who had an initially normal head CT scan deteriorate neurologically during their hospital course?

I would like to know if Sacramento County is going to change back one of their triage criterion to transient LOC.

Clayton H. Shatney, MD, San Jose, Calif: Who do you rely on to verify that the patient had LOC? The reason I am bringing this up is that a lot of times, paramedics will come in with a story that a passenger in the vehicle or a witness to the accident said that the patient was “out for a minute or 2,” but on closer scrutiny and in talking to the patient, you realize that they really didn’t have a true LOC. So I think it is important that this LOC be witnessed by somebody with training to determine that they truly had transient LOC, or you are going to spuriously increase the number of inappropriate transports to the trauma center. So, again, my question is, who made the declaration in this study, especially the prospective aspect of it, that the patients truly did have transient LOC?

Gregory K. Luna, MD, Spokane, Wash: I would like to applaud the authors for their efforts to challenge convention and make recommendations based on clinical investigations. Too often, trauma care changes are recommended based solely on intuition. However, when changes in practice are recommended based on these clinical investigations, it is essential that induction criteria and patient-specific data be clearly defined and that patients be stratified.

What were the mechanisms of injury among these patients? Were all patients high-impact injury victims? Do these data include persons who had sustained low-impact, low-energy isolated head injuries? Since there are patients who on initial evaluation have an essentially normal Glasgow Coma Scale score and head CT scan who subsequently deteriorate neurologically, do the authors believe that all patients who claim transient LOC should be admitted? If so, to which service should these patients with a normal neurological examination and head CT scan be admitted?

Dr Wisner: First of all, Dr Gregg, you mentioned that expedient orthopedic reconstruction is also an important factor.
that some hospitals can deliver better than others. We would certainly agree with that. Perhaps the paradigmatic example of that might be an open fracture. There were a number of those both in the retrospective and the prospective studies that we deemed not emergency operations but rather urgent operations. That is a very important point that I am glad he made.

Another question was whether questionable LOC rather than witnessed LOC was deemed an entry criteria into the study. That was a question that I think several questioners reiterated. The answer is yes, particularly in the first phase of the study, the prospective phase. We wanted to look at patients who had a questionable LOC because there was a great deal of sentiment in our community, particularly among the emergency medicine physicians who don’t work at a trauma center, that those patients always did well. It turns out that that just wasn’t the case. About half of the patients who turned out to have serious injury had questionable rather than definite LOC.

By phase 2, when we were doing this prospectively and the emergency medicine technicians had been urged to look more closely at what brought a patient to a trauma center, there were fewer patients who had questionable LOC, and things were a bit tighter.

Dave asked a question about whether or not you can discharge a patient without a head CT scan, and the answer is yes. Attached to that question was who in our center makes the decision about whether a patient gets a head CT scan, and I must tell you honestly that it is a variety of people, including trauma surgeons, residents on the trauma service, and emergency medicine faculty and residents as well. What I have been trying to promulgate at our center with some success so far is the notion that if you are going to send the patient home, even if the only indication for a head CT is transient LOC, that you ought to get a head CT scan before you send them out from the ED. For those patients who need to be admitted for some other reason, you don’t necessarily need a head CT scan right off the bat.

Dave also asked who goes to the ICU with a Glasgow Coma Scale score of 15? The answer to that question is, no one solely for that indication. Somebody with a Glasgow Coma Scale score of 15 who has a markedly abnormal head CT scan occasionally got admitted to the ICU, but most of those ICU admissions were for other injuries. Many of them were in older patients who had rib fractures and needed the rapid administration of epidural analgesia.

Who gets a head CT scan? I have already answered that, at least with respect to patients who have a Glasgow Coma Scale score of 15. Obviously, anybody with a Glasgow Coma Scale score of 14 or less also gets a head CT scan. There has been a good multi-institutional retrospective study authored by Steve Shackford a couple of years ago that demonstrated with much larger numbers than ours that those patients are not always free of serious head injury. Gail also asked about the 13 patients who were admitted for a variety of reasons other than surgery or neurosurgical reasons. Gail, those patients had other fractures or rib fractures that required analgesia.

Two patients died. Both had fairly normal head CT scans on arrival that deteriorated over time. Gail also asked if Sacramento County is going to change back to the way we used to do things, and we hope so. So far it hasn’t.

Mickey Shatney asked about who determined whether the patients had LOC. He made an important point that often the patient will give you a different story than observers will. We first questioned the patients. When the patients couldn’t give us a reliable story, we relied on observers.

Dr Luna asked about mechanisms of injury. Those were enumerated on a couple of slides, and they will be in the paper. He implied that most of the patients probably were motor-vehicle–accident victims, and that is exactly the case. There were also some falls and some assault victims. I already mentioned that 2 patients deteriorated over time. He also asked whether all LOC patients should be admitted. The answer to that is no. There are patients who can go home. I personally think that those patients who get sent home from the ED ought to have a head CT scan first. He also asked who should admit those patients, and I think if you have a trauma service, the trauma service should do it.

ARCHIVES OF INTERNAL MEDICINE

Pharmacological Effects of Antiarrhythmic Drugs: Review and Update

Peter R. Kowey, MD

Most antiarrhythmic drugs are potent compounds with a relatively narrow therapeutic index. When prescribed judiciously, they can have a key role in enhancing or prolonging the lives of patients with most common arrhythmias. But when misprescribed, through selection of an inappropriate drug or dosage regimen, the end result may range from inadequate control of the arrhythmia to a proarrhythmic effect. Ultimately, the optimal use of antiarrhythmic drug therapy depends in large part on understanding the pharmacodynamics and pharmokinetics of each antiarrhythmic drug. Despite the common classification of antiarrhythmic drugs into class I, II, III, or IV, each drug has a unique pharmacological profile and must not be considered interchangeable with other members of its class. Likewise, each patient is unique with respect to the innumerable factors that can alter the pharmokinetics of an antiarrhythmic drug, including coexisting diseases, concurrent drug therapies, and endogenous or age-related metabolic variations. This article provides an overview of the key pharmacodynamic and pharmokinetic characteristics of the major antiarrhythmic drugs in use. It also offers specific examples that may be used to ensure that patients receive the most appropriate therapy. (1998;158:325-332)

Reprints: Peter R. Kowey, MD, Division of Cardiovascular Diseases, Lankenau Hospital and Medical Research Center, Lankenau Medical Office Building East, Mainline Arrhythmia and Cardiology Consultants, 100 Lancaster Ave, Suite 556, Wynnewood, PA 19096.