

# Universal Medical Rescue Protocol Changed: “High Speed Auto Crash” Changed to “High Risk Auto Crash” in the Field Triage Decision Scheme.

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## ABSTRACT

At a crash scene, EMS providers must not only determine the severity of injury and initiate medical management, but also identify the most appropriate transport destination facility through a process called “field triage.” Proper decision making has a very significant impact on the outcome of injured subjects. Step III of the Field Triage Decision Scheme addresses mechanisms of injury and previously included “High Speed Auto Crash” as supported by initial estimated speed >40 MPH, major auto deformity >20 inches and intrusion into passenger compartment > 12 inches.

To take into account recent changes in trauma systems development and vehicle safety engineering and telemetry capabilities, the universally used Field Triage Decision Scheme was revised by a National Expert Panel organized by the Centers for Disease Control and Prevention. An extensive review of published evidence as well as analysis of crash injury databases was performed. New criteria targeted a 20% positive predictive value for Injury Severity Score greater than 15 (ISS>15) since more severely injured patients benefit most from transport to the highest level of trauma care. “High Speed Auto Crash” was revised to “High Risk Auto Crash” as supported by intrusion >12 inches at the occupant site or >18 inches anywhere in the vehicle as well as field telemetry consistent with high risk of injury. Rollover events and prolonged extrication were removed as criteria while death in the same occupant

compartment was retained. The occupant ejection criterion was changed to specify both partial and complete ejection.

The recent revision of the universally used Field Triage Decision Scheme has potential to greatly improve rescue and treatment of crash injury victims. The addition of “vehicle telemetry consistent with high risk of injury” provides a tremendous opportunity for the automotive and medical communities to work co-operatively to improve crash safety.

## INTRODUCTION

Crash injuries are a major global public health problem. Each year, nearly 1.2 million people worldwide are killed in road traffic crashes and 20 million to 50 million more are injured. Crash injuries account for 2.1% of global mortality and 2.6% of all disability-adjusted life years (DALYs) lost. Without appropriate action, by 2020, road traffic injuries are predicted to be the third leading contributor to the global burden of disease. The economic cost of road traffic crashes is enormous. Globally it is estimated that US\$518 billion is spent on road traffic crashes (1).

When someone is injured in a motor vehicle collision (MVC), the responding emergency medical services (EMS) providers must provide emergency care at the scene and then transport the patient to a health-care

facility for further evaluation and treatment. “Field triage” is the process by which EMS responders determine the facility to which an injured patient should be transported. Although all emergency departments provide basic emergency services, certain hospitals, known as “trauma centers”, have additional expertise and equipment for treating severely injured patients. In the United States, trauma centers are classified by the American College of Surgeons Committee on Trauma (ACS-COT) depending on the scope of resources and services available, ranging from Level I, which provides the highest level of care, to Level IV.

Whether an injured patient is triaged for transport to an appropriate level of care facility or not can have a very significant impact on that patient’s subsequent morbidity and mortality. Experience with field triage has confirmed the importance of destination decisions in trauma care. The National Study on the Costs and Outcomes of Trauma (NSCOT) recently evaluated the effect of trauma center care on mortality in moderately to severely injured patients; the study found a 25% reduction in mortality for severely injured patients who received care at a Level I trauma center rather than at a non-trauma center (2). This study examined data from Level I trauma centers and large non-trauma center hospitals (i.e., hospitals that treated  $\geq 25$  major trauma patients each year) in 15 metropolitan statistical areas in 14 states. Complete data for 1,104 patients who died in the ED or hospital were compared with 4,087 selected patients who were discharged alive. After adjusting for differences in case mix, including age, comorbidities, and injury severity, the researchers found that 1-year mortality was lower among severely injured patients treated at Level I trauma centers (10.4%) than those treated at large non-trauma center hospitals (13.8%) (relative risk [RR] = 0.75; 95% CI: 0.6–1.0). Those treated at Level I trauma centers also had lower in-hospital mortality (RR = 0.8; 95% CI: 0.8–1.0), fewer deaths at 30 days after injury (RR = 0.8; 95% CI: 0.6–1.0), and fewer deaths at 90 days after injury (RR = 0.8; 95% CI: 0.6–1.0).

While it may seem easiest to transport all injured patients to trauma centers, trauma centers are a limited resource that can be overwhelmed. Furthermore, the treatment delays that result when injured patients are transported greater distances to trauma centers when sufficiently capable non-trauma centers are in closer proximity may worsen the

clinical outcome of a subset of patients. Greater transport distances also place a very significant work burden on EMS responders, particularly in rural areas. Patients with less severe injuries might therefore be served better by transport to a closer ED. Transporting all injured patients to Level I trauma centers, when many do not require that high a level of resources and expertise, unnecessarily burdens those facilities and makes them less available for the most severely injured patients.

The initial recommendations from the ACS-COT in *Field Categorization of Trauma Patients* in 1976 (3) did not specify triage criteria, but they did contain physiologic and anatomic measures that allowed stratification of patients by injury severity. At that time, the ACS-COT developed guidelines for the verification of trauma centers, including standards for personnel, facility, and processes deemed necessary for the optimal care of injured persons. Subsequent studies in the 1970s and early to middle 1980s showed a reduction in mortality in those regions with specialized trauma centers (4-6). These studies led to a national consensus conference in 1987 that resulted in the first ACS field triage protocols, known as the “Triage Decision Scheme” for trauma patients. Since 1987, this Decision Scheme has served as the basis for the field triage for trauma patients in the majority of EMS systems in the United States. Individual EMS systems may adapt the Decision Scheme to meet the demands of the operational context in which they function. For example, the Decision Scheme may be modified to a specific environment (densely urban or extremely rural), to resources available (presence or absence of a specialized pediatric trauma center), or at the discretion of the local medical director. This Decision Scheme has been widely adopted by EMS systems around the world.

The “accuracy” of field triage is the degree of match between severity of injury and level of care. Maximally sensitive triage would mean that all patients with injuries appropriate to a Level I or Level II trauma center would be sent to such centers. Maximally specific triage would mean that no patients who could be treated at a Level III or Level IV center or community ED would be transported to a Level I or Level II center. Triage that succeeded in transporting only patients with high injury severity to a Level I or Level II center would maximize the positive predictive value (PPV) of the process, and triage that succeeded in transporting only low injury severity patients to a Level III, IV, or community ED

would maximize the negative predictive value (NPV).

Ideally, all persons with severe, life-threatening injuries would be transported to a Level I or Level II trauma center, and all persons with less serious injuries would be transported to lower-level trauma centers or community EDs. Unfortunately, patient differences, occult injuries, and the complexities of patient assessment in the field make it impossible to attain perfect accuracy in triage decisions. Inaccurate triage that results in a patient who requires higher-level care not being transported to a Level I or Level II trauma center is termed “undertriage.” The result of undertriage is that a patient does not receive the specialized trauma care required. “Overtriage” occurs when a patient who does not require care in a higher-level trauma center is nevertheless transported to such a center, thereby unnecessarily consuming scarce resources. In the triage research literature, all of these measures—sensitivity, specificity, PPV, NPV, undertriage, and overtriage—along with measures of association such as the odds ratio, are used to assess the effectiveness of field triage.

Like sensitivity and specificity applied to screening tests, reductions in undertriage are usually accompanied by increases in overtriage, and vice versa. Because the potential harm associated with undertriage (i.e., causing a patient in need of trauma center care not to receive appropriate care) is high and could result in death or substantial morbidity and disability, trauma systems frequently err on the side of minimizing undertriage rather than minimizing overtriage. Target levels for undertriage rates within a trauma system might range from 1% to 5% of patients requiring Level I or II trauma center care, depending on the criteria used to determine the undertriage rate (e.g., death, ISS) (7). Acceptable overtriage rates vary, but might range from 25% to 50% (7). As field triage continues to change on the basis of new research findings, overtriage rates might be reduced while maintaining low undertriage rates so that limited health care resources can be optimally used.

## METHODS

The National Expert Panel of Field Triage is comprised of three dozen individuals with expertise in acute injury care representing a broad range of interested parties, including EMS providers and

medical directors, emergency medicine physicians and nurses, adult and pediatric trauma surgeons, the automotive industry, public health, and Federal agencies. This Panel is responsible for periodically reevaluating the Decision Scheme, determining if the criteria are consistent with current scientific evidence and compatible with advances in technology (e.g., vehicular telemetry), and, as appropriate, recommending revisions to the Decision Scheme. In May 2005, with support from NHTSA’s Office of Emergency Medical Services, the Centers for Disease Control and Prevention (CDC) convened the Panel to evaluate and revise the 1999 Decision Scheme. The Panel recognized that peer-reviewed studies would be the preferred basis for its decisions regarding revision of the Decision Scheme, but noted that literature that specifically addresses or supports the Decision Scheme or its component criteria is sparse. Thus, the Panel decided to use multiple approaches to identify as much relevant published literature as possible and to consider other sources of evidence (e.g., consensus statements, policy statements). Finally, when definitive research, consensus, or policy statements were lacking, the Panel based revisions and recommendations on the expert opinion of its members.

In preparation for the first meeting of the Panel, a structured literature review (8) was performed which examined the entire Decision Scheme and each of its component steps. MEDLINE was used and English-language articles published between 1966 and 2005 were searched using the Medical Subject Headings (MeSH) “emergency medical services,” “wounds and injury,” and “triage.” Additionally, the reference sections of identified papers were searched to identify other potential articles. A total of 542 titles were identified, of which 80 relevant articles were subsequently reviewed and presented to the Panel at its first meeting. During the subsequent two-year revision process, panel members also identified additional relevant literature that had not been examined during the structured review. Primary emphasis was placed on articles published since the development of the 1999 version of the Decision Scheme.

At its initial meeting, the Panel determined that the limited evidence was most compelling in support of the physiologic (Step One) and anatomic (Step Two) criteria of the Decision Scheme. Agreement was unanimous that the mechanism of injury criteria (Step Three) needed revision, and approximately half of the

Panel recommended that the special considerations step (Step Four), which addresses comorbidity and extremes of age, be revised. Ultimately, the Panel elected to undertake limited revisions of the physiologic and anatomic steps and more substantive revision of the mechanism of injury and special considerations steps. Working subgroups of the Panel then conducted further detailed review of the literature and developed recommendations regarding individual components of the Decision Scheme, focusing on the determination of the accuracy of existing criteria and on identifying new criteria needed for both Steps Three and Four of the Decision Scheme.

The working subgroups used ISS >15 generally as the threshold for identifying severe injury; however, other factors (e.g., need for prompt operative care, intensive care unit [ICU] admission, case fatality rates) were also considered. Varying methodologies and different analyses were used to determine the appropriateness of individual mechanism of injury (Step Three) criteria (e.g., ISS or resource utilization). Thus, a threshold of 20% PPV to predict severe injury (ISS >15), major surgery, or ICU admission was used to place new criteria into discussion for inclusion as mechanism of injury criteria. PPV <10% was used as a threshold for placing existing mechanism of injury criteria into discussion for removal from the Decision Scheme. In selecting the PPV thresholds, the Panel recognized the limitations of data available in the relevant literature. In addition to the criteria automatically placed into discussion based on PPV <10% or >20%, Panel members also could nominate criteria having PPV 10%–20% for further discussion.

The recommendations of the working subgroups were presented to the entire Panel in April 2006 for discussion, minor modification, and formal adoption as revisions to the Decision Scheme. Final consensus on the recommendations in the Decision Scheme was reached on the basis of supporting or refuting evidence, professional experience, and the judgment of the Panel. The revised Decision Scheme (Figure 1), with a draft description of the revision process, was distributed to relevant associations, organizations, and agencies representing acute-injury care providers and public health professionals for their review and endorsement. Following endorsement by multiple organizations, the Decision Scheme was published in 2006 edition of the

American College of Surgeons' *Resources for the Optimal Care of the Injured Patient*.

The definitive detailed description of the process of revision and the rationale behind the new decision scheme was published in the medical literature in January 2009 (9). Readers should refer to this definitive monograph for information regarding the full extent of changes made to the Field Triage Decision Scheme. In order to increase awareness within the international automotive safety community of these important changes to the Decision Scheme, this current manuscript for the 21<sup>st</sup> Enhanced Safety of Vehicles Conference focuses only on the changes to Step Three (Mechanism of Injury) criteria relevant to injured MVC occupants.

## RESULTS

### Criterion Deleted: Extrication Time >20 Minutes

In determining whether to retain extrication time >20 minutes as a criterion in the 2006 Decision Scheme, the Panel recognized potential problems with field use of this criterion. It is difficult for EMS personnel to determine exact times while managing the scene of a crash and assessing and treating vehicle occupants. Adverse weather conditions and darkness can further complicate matters. Additionally, because most EMTs are trained only to do light extrication, and must call someone else for heavy rescue, it is unclear when EMS personnel should “start the clock” for the 20-minute time frame.

The Panel recognized that, although lengthy extrication time may be indicative of increasing injury severity, the new vehicle construction and improved occupant protection systems in modern automobiles appear to be causing an increase in the number of non-seriously injured patients who require >20 minutes for extrication. Although occupants may require extrication due to lower extremity injuries, they may not have sustained serious life-threatening injuries to the head or torso due to improved occupant protection systems. The Panel determined that the changes made to the triage protocol for cabin intrusion adequately addressed issues relevant to extrication time, and elected to delete extrication time as a criterion (Table 2, Figure 1). This also decreases the number of criteria with which EMS personnel must contend in the time-sensitive decision making required on the scene of a motor vehicle crash.

**Table 1.****Old Step 3 (Mechanism of Injury) Criteria**

*High speed auto crash*  
*Initial speed > 40 mph*  
*Major auto deformity > 20 inches*  
*Intrusion into passenger compartment > 12 inches*

*Ejection from automobile*

*Death in same passenger compartment*

*Extrication time >20 minutes*

*Rollover*

Falls > 20 feet

Auto-pedestrian/auto-bicycle injury with significant (>5 mph) impact

Pedestrian thrown or run over

Motorcycle crash > 20 mph or with separation of rider from bike

**Criterion Deleted: Rollover Crash**

Published data indicate that rollover crash event has a PPV for severe injury of <10%. A multivariate analysis of 621 crashes indicated that rollover crash was not associated with ISS >15 (10). Analysis of contemporary NASS CDS research confirmed that rollover crash (in the absence of ejection) was not associated with increasing injury severity (AIS >3) although rollovers with occupant ejection were clearly associated with increasing injury severity (11). Review of current NASS CDS data also showed that a >20% risk of ISS >15 was not associated with the number of quarter turns in a rollover crash, nor the landing position of the vehicle or maximum vertical or roof intrusion. (11)

The increased injury severity associated with rollover crashes is seen when an occupant is partially or completely ejected from the vehicle, which most frequently occurs when restraints are not used. The decision was made to broaden the ejection criterion to include both partial and complete ejection for

**Table 2.****Current Step 3 (Mechanism of Injury) Criteria**

*High-Risk Auto Crash*  
*Intrusion: >12 in. occupant site or >18 in. any site*  
*Ejection (partial or complete) from automobile*  
*Death in same passenger compartment*  
*Vehicle telemetry data consistent with high risk of Injury*

Falls  
 Adults: >20 ft. (one story = 10 ft.)  
 Children: >10 ft. or 2–3 times child's height

Auto versus pedestrian/bicyclist thrown, run over, or with significant impact (>20 mph)

Motorcycle crash >20 mph

transport to a trauma center as a mechanism of injury associated with high-risk auto crash (see below). As a result of these findings, the Panel concluded that rollover crash, in and of itself, is not associated with increasing injury severity and should not stand as a separate criterion. The Panel chose to delete rollover crash criterion from the 2006 Decision Scheme (Table 2, Figure 1).

**Criterion Retained: Ejection (Partial or Complete) from Automobile**

There was evidence to support that ejection is associated with increased severity of injury. A multivariate analysis of data collected from 1996–2000 at the Royal Melbourne Hospital in Victoria, Australia, examined 621 crashes and found that ejection from the vehicle was associated with major injury defined as ISS >15, ICU admission >24 hours requiring mechanical ventilation, urgent surgery, or death (OR = 2.5; CI: 1.1–6.0) compared with crashes without ejection (10). A retrospective evaluation of NASS data collected during 1993–2001 was conducted to determine the crash characteristics

associated with significant chest and abdominal injuries; this evaluation indicated that the predictive model that produced the best balance between sensitivity and specificity included ejection as a variable (12). A person who has been ejected from a vehicle as a result of a crash has been exposed to a significant transfer of energy with the potential to result in severe life- or limb-threatening injuries. Lacking the protective effects of vehicle restraint systems, occupants who have been ejected may have struck the interior many times prior to ejection (13). Further, ejection of the patient from the vehicle increases the chance of death by 25 times, and one of three ejected victims sustains a cervical spine fracture (13). No literature reviewed argued conclusively for removal of this criterion. Therefore, on the basis of the available, albeit limited, evidence, combined with the Panel's experience, ejection from the vehicle was retained as a criterion (Table 2, Figure 1).

The Panel further concluded that, because the literature reviewed showed that partial or complete ejection is associated with severe injury, ICU admission, urgent surgery, and death, even if these patients do not meet physiologic or anatomic criteria, they still warrant a trauma center evaluation based upon mechanism only. Additionally, ejections of vehicle occupants are not that frequent. Transporting all such patients for evaluation would not be expected to overburden the system. These patients may be transported to the closest appropriate trauma center, which, depending on the trauma system, need not be the highest level trauma center.

#### **Criterion Retained: Death in Same Passenger Compartment**

In the context of a MVC, death of an occupant in a vehicle is highly indicative that a significant force has been applied to that vehicle and all of its occupants. A prospective study of MVC victims in Suffolk County, New York, indicated that death of an occupant in the same vehicle was associated with increased odds for major surgery or death (AOR = 39.0; CI: 2.7–569.6) and ISS >15 (AOR = 19.8; CI: 1.1–366.3) (14). A prospective study of 1,473 patients, which did not account for the impact of physiologic or anatomic criteria, indicated that 3 of 14 occupants in a vehicle with a fatality had ISS >15, resulting in PPV of 21.4% for severe injury by this mechanism (15)). A review of data concerning 621 crash victims indicated that occupants of vehicles in

which a fatality occurred comprised 11% of the patients evaluated and 7% of the patients with major injury, but fatality of an occupant was not statistically associated with major injury (10). In its discussions, the Panel noted that two of the three studies cited above demonstrated a PPV >20% for ISS >15, as well as increased odds for major surgery or death of occupants in a vehicle in which a fatality occurs. Although the remaining study did not show a statistical association with major injury, this single study was not compelling enough to delete this criterion. Panel members affirmed that, in their clinical experience, death of an occupant in a vehicle is associated with a risk of severe injury to any surviving occupant.

After reviewing the evidence, the Panel concluded that death in the same passenger compartment should be retained as a criterion for the 2006 version of the Decision Scheme (Table 2, Figure 1). Surviving passengers should be transported to the closest appropriate trauma center. As the number of patients who fall into this category is small, such requirement for transport would not overburden the system.

#### **Criterion Modified: Intrusion >12 inches at Occupant Site, or >18 inches at Any Site**

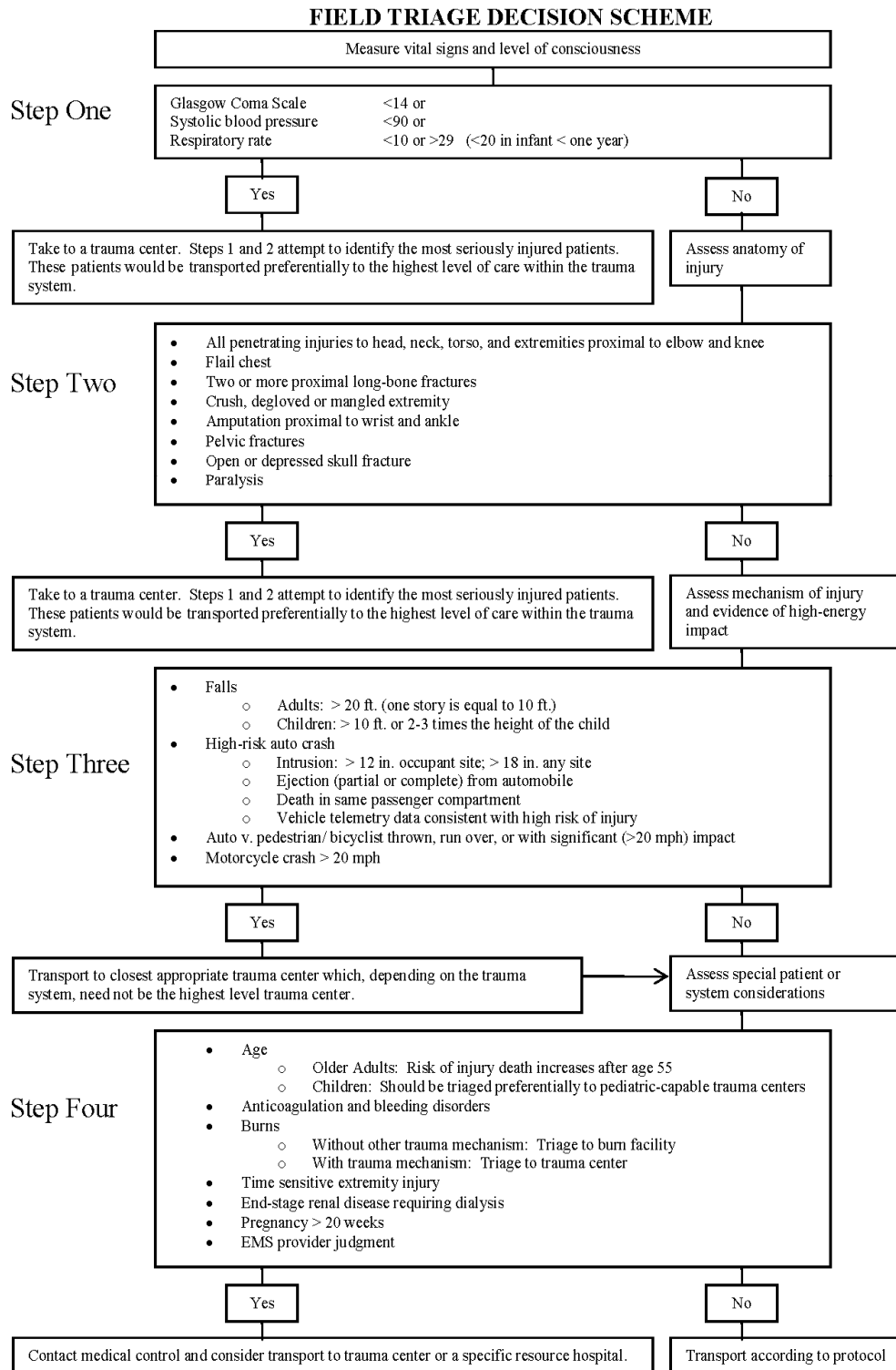
Evidence examined in consideration of this criterion included the 2003 retrospective study of 621 MVC victims which did not account for physiologic or anatomic criteria reported that cabin intrusion >30 cm (>11.8 inches) was associated in univariate analysis ( $p = <0.0001$ ) with major injury, defined as one of the following: ISS >15; ICU admission for >24 hours requiring mechanical ventilation; urgent cranial, thoracic, abdominal, pelvic-fixation, or spinal-fixation surgery; or death. However, this association was not statistically significant in multivariate analysis (OR 1.5; 95% CI: 1.0–2.3;  $p = 0.047$ ) (90). Similarly, a univariate analysis of New York State data that examined the incremental benefit of the individual ACS triage criteria, identified increased odds of severe injury (ISS >15) for 30 inches of vehicle deformity (OR = 4.0; 95% CI: 2.1–7.8), 24 inches of intrusion on the side of the vehicle opposite the victim (OR = 5.2; 95% CI: 2.6–10.4), and 18 inches of intrusion on the same side of the vehicle as the victim (OR = 7.1; 95% CI: 3.8–13.0) (58). However, none of these findings was statistically significant in multivariate analysis.

Data from the National Automotive Sampling System Crashworthiness Data System (NASS CDS), which includes statistical sampling of all crashes occurring in the United States, indicated that a very large crush depth, 30 inches in frontal collisions and 20–24 inches in side-impact collisions, was needed to attain a PPV of 20% for ISS >15 injury to occupants (16). External crush of such great extent is difficult to measure in the field without reference information from an undamaged exemplar vehicle. The Panel also recognized that recent changes in vehicle design and construction have likely reduced the effect of crush on the risk for severe injury in crashes. Whereas older vehicles were more likely to transmit the kinetic energy of crashes to vehicle occupants and cause severe injuries, newer vehicles are designed to crush externally and absorb energy, protecting passenger compartment integrity and occupants. Additionally, the Panel took note of the difficulty of using deformity or crush criteria in the field. Crash sites are difficult environments in which to estimate such measures, and little might be left of a vehicle to serve as a reference point for determining crush depth. For example, in one study, only 1.0% of 94 cases with 30 inches or more of deformity were documented by EMS personnel (17). The Panel concluded from these three studies that external vehicle crush depth or deformity was not a useful indicator for severe injury.

The Panel reviewed NASS CDS data from 1997-2005 which showed that intrusion of 12 inches at the occupant site or 18 inches of intrusion at any site had a PPV of 20% for ISS>15 for MVC occupants (16). Similarly, stuck side lateral intrusion of 12 inches was needed to attain a PPV of 20% for ISS>15 to lateral impact crash occupants (16). Furthermore, extensive anecdotal experience in trauma practice indicates that increasing cabin intrusion is indicative of an increasing amount of force upon the vehicle and potentially upon the occupant. Also, side-impact intrusions could present special clinical concerns that had not been fully recognized in existing research, given the limited space between the impact and occupant. Finally, although modern vehicles have better energy-absorbing capability, vehicle incompatibility (crash involving a large vehicle versus a small vehicle) might be increasingly significant in the level of vehicle intrusion in crashes.

#### **Criterion Added: Vehicle Telemetry Data Consistent with High Risk of Injury.**

In earlier versions of the Decision Scheme, initial vehicle speed > 40 mph, vehicle deformity >20 inches, and intrusion >12 inches for unbelted occupants were included as mechanism of injury criteria. NASS data indicate that risk for injury, impact direction, and increasing crash severity are linked (16). An analysis of 621 Australian MVCs indicated that high-speed impacts (>60 km/hr [>35 mph]) were associated with major injury, defined as ISS >15, ICU admission >24 hours requiring mechanical ventilation, urgent surgery, or death (OR = 1.5; 95% CI: 1.1–2.2) (10). Previously, the usefulness of vehicle speed as a criterion had been limited because of the challenges to EMS personnel to estimate impact speed accurately. However, new Advanced Automatic Collision Notification (AACN) technology installed in some automobiles, now in approximately six million vehicles in the United States and Canada, (18) can identify vehicle location, measure change in velocity (“delta V”) during a crash, and detect crash principal direction of force (PDOF), airbag deployment, rollover, and the occurrence of multiple collisions (18, 19). As a result, and in recognition that this information might become more available in the future, vehicle telemetry data consistent with a high risk for injury (e.g., change in velocity, principal direction of force) was added as a triage criterion (Table 2, Figure 1). This criterion was intentionally left nonspecific at the time of publication, as this emerging area requires additional evaluation of available data to define the exact components (e.g., belt use, delta V, PDOF) consistent with a high risk for injury. CDC is working with the automotive industry and experts in public health, public safety, and health care to examine how data collected by AACN systems can be used to predict injury severity, conveyed to EMS services and trauma centers, and integrated into the field triage process.



WHEN IN DOUBT, TRANSPORT TO A TRAUMA CENTER.

**Figure 1. New field triage decision scheme**

## CONCLUSION

The universally used Field Triage Decision Scheme was recently revised using a National Expert Panel convened by the Centers for Disease Control and Prevention, the National Highway Traffic Safety Administration and the American College of Surgeons Committee on Trauma. This Panel reviewed the available evidence and proposed revisions which were endorsed by multiple professional organizations.

Implementation and updating of these protocols at the local level will require a substantial educational and informative effort to ensure its wide scale implementation. The CDC, with additional funding from NHTSA, is developing an educational toolkit for State and local EMS medical directors, State EMS Directors, EMS providers, and public health officials. The tool kit will provide teaching aids to help EMS providers understand why the Decision Scheme was revised and how those revisions can be tailored to the needs of their communities. CDC, through its partner organizations, will distribute the tool kit to EMS jurisdictions throughout the United States. This toolkit also will be available online from CDC at <http://www.cdc.gov> for downloading and ordering free of charge. Providing the revised Decision Scheme to EMS administrators and providers should improve care for trauma patients nationwide and lead to reduced morbidity, mortality, disability, and costs from injuries.

The evaluation of trauma care in the prehospital environment and the evidence supporting appropriate care is necessarily an ongoing process. The current revisions to the Field Triage Decision Scheme were made on the basis of the best evidence currently available. Limitations in available data clearly indicate the need for additional research. Conducting research in the prehospital environment and in EMS presents multiple challenges, including a lack of trained investigators, legal and regulatory barriers, lack of appreciation and interest in research among EMS providers, lack of funding, and limited infrastructure and information systems to support research efforts (20, 21). Efforts are underway to address these barriers, including efforts to prioritize research, as in CDC's Acute Injury Care Research Agenda: Guiding Research for the Future (22) and The National EMS Research Strategic Plan (23), as well as in development of new databases that can provide more useful information and support data-

driven changes (e.g., NTDB, National EMS Information System [NEMSIS]) (24). Additional research efforts specifically related to field triage are needed, including cost-effectiveness research. Additional funding targeting research into triage decisions and triage criteria will be necessary to support these efforts. Also, research in triage represents an important area in which public health and EMS can collaborate to improve trauma surveillance and data systems and develop the methodologies needed to carry out the continuing analysis and evaluation of the 2006 Decision Scheme and its impact on the care of the acutely injured.

For the automotive safety community, the new Decision Scheme as well as the open, thorough and inclusive process used to revise it demonstrates clear recognition that there are many stakeholders in efforts to enhance vehicle safety. The revisions and their implementation at the local level demonstrate that the EMS and trauma communities are adjusting their protocols and procedures to account for advances in vehicle engineering and occupant protection. Improved utilization of limited and expensive health care resources will help to decrease the societal costs of motor vehicle crash injuries. The insertion of an open criterion of "vehicle telemetry consistent with high risk of injury" provides the automotive community with a tremendous opportunity to explore technological innovations that can improve safety and crash outcomes. Coupled with planned research efforts by CDC, NHTSA as well as regional EMS and trauma systems to prospectively collect data regarding the effect and efficacy of the new triage criteria, the automotive community will soon have access to much better real-life crash information. This rapid feedback regarding vehicle safety performance will guide and shorten the cycle of improvements necessary for the enhanced safety of vehicles.

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## REFERENCES

1. Peden, M. Global Collaboration on Road Traffic Injury Prevention. 2005. International Journal of Injury Control and Safety Promotion. June: 12:85-91.
2. MacKenzie EJ, Rivara FP, Jurkovich GJ, et al. A national evaluation of the effect of trauma center care on mortality. 2006. New England Journal of Medicine. 354:366-78.
3. Mackersie RC. History of trauma field triage development and the American College of Surgeons criteria. 2006. Prehospital Emergency Care. 10:287-94.
4. Guss DA, Meyer FT, Neuman TS, et al. The impact of a regionalized trauma system on trauma care in San Diego County. 1989. Annals of Emergency Medicine. 18:1141-5.
5. Campbell S, Watkins G, Kreis D. Preventable deaths in a self-designated trauma system. 1989. The American Surgeon. 55:478-80.
6. West JG, Trunkey DD, Lim RC. Systems of trauma care: a study of two counties. 1979. Archives of Surgery. 114:455-60.
7. American College of Surgeons. Resources for the optimal care of the injured patient: 2006. Chicago, IL: American Colleges of Surgeons; 2006.
8. Lerner EB. Studies evaluating current field triage: 1966-2005. 2006. Prehospital Emergency Care. 10:303-6.
9. Sasser SM, Hunt RC, Sullivent EE, Wald MM, Mitchko J, Jurkovich GJ, Henry MC, Salomone JP, Wang SC, Galli RL, Cooper A, Brown LH, Sattin RW. Guidelines for field triage of injured patients: Recommendations of the National Expert Panel on Field Triage. 2009 Morbidity and Mortality Weekly Report. 58(RR-1):1-35.
10. Palanca S, Taylor DM, Bailey M, Cameron PA. Mechanisms of motor vehicle accidents that predict major injury. 2003. Emergency Medicine (Fremantle). 15: 428-8.
11. Eigen AM. Rollover crash mechanisms and injury outcomes for restrained occupants. Washington, DC: National Highway Traffic Safety Administration; 2005. Available at <http://www-nrd.nhtsa.dot.gov/Pubs/809894.PDF>.
12. Nirula R, Talmor D, Brasel K. Predicting significant torso trauma. 2005. Journal of Trauma. 59:132-5.
13. Getz SA, Rodriguez EK. Trauma. In: Elling B, Smith M, Pollak AN, eds. Nancy Caroline's emergency care in the streets. 6<sup>th</sup> ed. Boston: Jones and Bartlett Publishers; 2008:17.5-17.29.
14. Henry MC, Hollander JE, Alicandro JM, Cassara G, O'Malley S, Thode HC. Incremental benefit of individual American College of Surgeons trauma triage criteria. 1996. Academic Emergency Medicine. 3:992-1000.
15. Knopp R, Yanagi A, Kallsen G, Geide A, Doehring L. Mechanism of injury and anatomic injury as criteria for prehospital trauma triage. 1988. Annals of Emergency Medicine. 17:895-902.
16. Wang, SW. Review of NASS CDS and CIREN data for mechanism criteria for field triage. Presented at the National Expert Panel on Field Triage meeting, Atlanta, Georgia; November 15, 2005.
17. Henry MC. Trauma triage: New York experience. 2006. Prehospital Emergency Care. 10:295-302.
18. Ball WL. Telematics. 2006. Prehospital Emergency Care. 10:320-1.
19. Hunt RC. Emerging communication technologies in emergency medical services. 2002. Prehospital Emergency Care. 6:131-6.
20. Jurkovich GJ, Mock C. Systematic review of trauma system effectiveness based on registry comparisons. 1999. Journal of Trauma. 47(Suppl 3):S46-55.
21. Sayre MR, White LJ, Brown LH, McHenry SD: The National EMS Research Agenda Executive Summary. 2002. Annals of Emergency Medicine. 40:636-43.
22. CDC. CDC acute injury care research agenda: guiding research for the future. Atlanta, GA: US

Department of Health and Human Services, CDC;  
2005. Available at  
<http://www.cdc.gov/ncipc/dir/ARagenda.htm>.

23. Sayre MR, White LJ, Brown LH, McHenry SD, for the National EMS Research Strategic Plan Writing Team. The National EMS Research Strategic Plan. 2005. Prehospital Emergency Care. 9:255-66.

24. Sattin RW, Corso PS. The epidemiology and costs of injury. In: Doll L, Bonzo S, Mercy J, Sleet D, eds. Handbook on injury and violence prevention interventions. New York, NY: Kluwer Academic/Plenum Publishers; 2006:3-19.