EVALUATION OF TRAUMA TRIAGE CRITERIA FOR AIR MEDICAL TRANSPORT

Preliminary Project Report EMS/Trauma Research Grant Program, September 2010

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INTRODUCTION

Triage of the trauma patient is a complex and challenging task. Deciding whether or not to use air medical services to transport severely injured patients from the scene to the trauma center adds complexity to the triage process. Over the last decade, air medical transport has become an integral component in the care of the trauma victim. The Association of Air Medical Services (AAMS) estimates that there are nearly 400,000 rotor wing transports annually, with an additional 150,000 patient flown by fixed wing aircraft in the US each year. While field trauma triage criteria exist for EMS personnel to use in identifying trauma patients, these criteria remain poorly defined and little tested. The development of evidence based and tested trauma triage criteria designed to determine which patients will require the resources of a Level 1 trauma center, will making the decision to transport by air more objective and will result in a more effective use of this mode of transportation.

CONTENTS

REVIEW OF THE LITERATURE

Trauma Triage Criteria

Air medical transport has been proven to provide benefit to patients and to EMS systems alike. EMS systems and their patients with access to air medical services benefit on several levels from: improved access to care; the experience of the crews; and from an economic standpoint, within a well designed system.(1) Survival benefits have been documented for patients who have access to air transport from the scene.(2;3) The State of Ohio has state-mandates regarding the use of pre-hospital trauma triage criteria to assist in the identification of major trauma victims. These criteria are primarily based on physiologic findings at the time of injury as well as anatomic findings. By state statute, trauma patients who meet these criteria must be evaluated in an American College of surgeons (ACS)-verified trauma center. In addition, more specific state-mandated geriatric trauma triage guidelines exist for patients 70 years or greater.

Need for Standardization in Determining Method of Transport to a Trauma Center

While these criteria are used to identify trauma victims who require transport to a trauma center from the out of hospital setting, they do not specifically address the mode by which such patients should be transported (i.e. ground vs. air medical transport). Each of Ohio's ten designated trauma regions is responsible for defining protocols that address the use of air medical transport under appropriate conditions for trauma patients and as such, there are no standard guidelines or protocols in place to assist in such decision making.

Transporting trauma victims directly from the scene using air medical transport services provides two potential advantages: speed of transport for delivering patients with time-critical injuries to facilities that can provide appropriate services and special skills of air medical crews (e.g. advanced airway). Multiple studies have documented the benefits of air medical transport in trauma;(4;5) one study has documented that air medical transport is cost-effective in this setting.(6) However, over-triage (delivering patients unnecessarily to trauma

centers) poses several significant concerns. Over-triage can potentially overwhelm the resources of trauma systems and potentially make transport unavailable for subsequent victims who may have more appropriate need for transport to a Level 1 center. Air medical transport is an expensive resource that can add significant costs to the care of the trauma victim as well as the medical system itself. Moreover, air medical transport has measurable safety risks and such risks need to be weighed against the benefit of its use. For example, in 2008, there were 11 major air medical crashes resulting in 32 fatalities.

Purpose

The purpose of this investigation is to identify predictors of hospital admission, from among currently used trauma triage criteria, for trauma patients transported via air medical transport to the two Level 1 trauma centers in Central Ohio.

Methods

This is a prospective, observational, non-interventional analysis of all injured patients transported by air medical transport in central Ohio. This report represents a preliminary analysis of the first six months of data collection. The final report will include an analysis of 24 months of data, and will include children transported to a Level 1 trauma center.

Inclusion Criteria

For this preliminary analysis of data, all injured, adult (age > 15 years) patients transported directly from an accident scene by MedFlight to either one of two adult Level 1 Trauma Centers in central Ohio will be eligible for the study. These two centers receive about 90% of all air transports in the central Ohio area. The analysis will be limited to these Level 1 centers in order to limit any variability in care provided by different levels of trauma care.(7-9)

Data Collection

IDENTIFICATION OF TRIAGE CRITERIA USED TO CALL FOR AIR TRANSPORT

To collect data regarding the decision to use air medical transport at the scene of the trauma, a mandatory documentation tool was added to the MedFlight electronic record. The documentation tool used by the air medical service personnel includes a listing of the specific trauma triage criteria used by ground EMS to determine the use of air medical transport for their patient. These "reasons" for the use of air transport include both criteria for major trauma and as mechanism of injury and must be entered by the transporting crew before completing the paperwork for each case.

SCENE INFORMATION DATA COLLECTION

Demographic information from the scene was collected retrospectively from MedFlight records and included the scene location, distance from the trauma hospital (loaded miles) and the level of training of the responding EMS providers (ALS versus BLS service). Other information collected for each trauma scene transport Included:

- *Injury severity score, (ISS)*
- *Need for surgical intervention (open fractures and all non-orthopedic surgery) within 24 Hours of admission,*
- *Patient admission to an intensive care unit (ICU),*
- *Need for blood products within the first 24 hours,*
- *Length of ICU stay,*
- *Total hospital length of stay,*
- *Early death (within 24 hours of admission),*
- *Late death (>24 hours), and,*
- *Predicted mortality using TRISS methodology.(10;11) Demographisc:Age, race, gender, insurance status*
- *Glasgow Coma Scale Score*

- *Mechanism of injury (blunt vs. penetrating)*
- *Prehospital endotracheal intubation (ETI)*

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Results

A preliminary analysis of demographics, and outcomes including mortality, surgical intervention, admission to ICU, need for blood products- for the 249 patients transported by air medical transport was conducted to determine any association of the variables, air medial transport and use of trauma center resources. (Table 1.)

TABLE 1. DEMOGRAPHICS

October 2009-April 2010	Population
	N=249
Age, median [IQR]	38 [23-53]
Male (%)	171 (69%)
White (%)	240 (96%)
Rural Location (%)	145 (58%)
Distance, Miles [IQR]	39 [28-53]
Insurance	
Private (%)	133 (53%)
Self Pay (%)	52 (21%)
Medicare/Medicaid	56 (22%)
Workers	8 (3%)
Penetrating Injury (%)	12 (5%)
ED GCS <9 (%)	41 (16%)
ISS, median [IQR]	10 [5-17]
ISS >15 (%)	77 (31%)
EMS ETI (%)	33 (13%)
ICU Admit (%)	95 (38%)
ICU Stay >24 hours (%)	96 (39%)
Blood w/in 24 hours (%)	30 (12%)
Non-orthopedic surgery w/in 24 hr (%)	79 (32%)
ICU LOS, median [IQR]	0 [0-2]
Hospital LOS, median [IQR]	3 [1-8]
Mortality (%)	9 (4%)
Early Death, <24 hours (%)	2 (<1%)

Injury characteristics for the 249 subjects are listed in Table 2.

TABLE 2. INJURY CHARACTERISTICS

Injury Criteria (October 2009-April 2010)	Population N=249
Abnormal Vitals (HR >120, SBP<90, Abnormal RR)	18 (7%)
Spinal Cord Injury	18 (7%)
2 or > Fx of Humerus/Femur	8 (3%)
2nd or 3rd Degree Burns >10% BSA	3 (1%)
Ab tenderness/distention/seat belt sign	21 (8%)
Proximal Amputation	1 (<1%)
Arm/Leg Inj with NV Injury	8 (3%)
Auto vs. Pedestrian	6 (2%)
Crush Head Injury	19 (8%)
Crush Extremity Injury	9 (4%)
Failure to Localize	16 (6%)
Falling LOC	23 (9%)
Fall >20 feet	13 (5%)
Flail Chest	0 (0%)
GCS 13 or less	41 (16%)
MVC with death of occupant	8 (3%)
MVC with ejection	20 (8%)
MVC with high risk mechanism	49 (20%)
LOC >5 minutes	33 (13%)
MVC >20 mph	28 (11%)
Pelvic Injury	13 (5%)
Proximal Penetrating Injury	0 (0%)
Penetrating Head Injury	21 (8%)
Burn to Face	4 (2%)
Tension Pneumothorax	0 (0%)

Individual criteria from Table 2 were examined for their ability to accurately contribute to an appropriate triage decision. The analysis involves building a multivariable logistic regression model predicting hospital admission (SAS 9.1, SAS Institute, Cary, NC). The model will use patient-specific as well as injury-specific predictor and confounding variables to model a dichotomous outcome of hospital admission using a generalized linear model (GLM). Variables are chosen for potential inclusion in the multivariable model via univariate association with survival to discharge ($\chi 2$ for categorical variables, logistic regression for continuous variables), clinical importance of a known

or suspected confounding factor, and overall model fit (Hosmer-Lemeshow goodness-of-fit). Variables found not to be associated with admission to the hospital and not considered clinically important will be removed via a non-automated backward-stepwise selection. First order interaction terms will be incorporated into the model one at a time and included if found to be significant ($p < .10$).

Using the following variables from Table 1: Blood products within 24hours, ICU admit for > 24hours, or Non-Orthopedic Surgery w/in 24 hours and the criteria from Table 2 (GCS 13 or less, MVC with high risk mechanism, LOC > 5 minutes and MVC > 20 MPH), the following prediction model in Table 3 was developed.

TABLE 3. PRELIMINARY MODEL

Model to predict need for Level 1 Trauma Center	
Sensitivity	**41% (37-44%)**
Specificity	**91% (83-95%)**
PPV	**85% (75-91%)**
NPV	**57% (54-59%)**
LR+	**2.83**
LR-	**0.61**
Total Population: 249. Population that had one of the four outcomes=134	

The model (Table 3) does not include nor does it evaluate other predictors of injury severity or illness such as ISS, insurance status, PMH, etc as these types of variables are not available to medics at the scene and therefore would not be beneficial in developing criteria for predicting resource needs. Age did not add to the model and was not included.

These are preliminary findings using about 20% of the data that we intend to collect. It is probable that additional variables will become available for inclusion in the model when the final data set is obtained.

In its incomplete form, the model above tells us that the presence of one of these variables is fairly predictive of the use of a Level 1 trauma resource and as such it should prompt the use of helicopter transport. However, the absence of these variables does not preclude the use of helicopter transport as the sensitivity is not precise.

SIGNIFICANCE

It has been noted that air medical transport of the trauma victim is the mechanism by which most trauma patients can access Level 1 or 2 trauma centers in less than 60 minutes(12) and that Level 1 trauma care does result in distinct outcome benefits for these patients when compared to other levels of care.(4) But, this benefit often comes with a significant level of over-triage. A 2005 report from the National Highway Traffic Safety Administration (NHTSA) states:

> "Better utilization of air medical services can produce reductions in mortality and morbidity of crashes. Such benefits can be achieved with faster response and transport times, higher quality care at the scene

> and in transport, and at the highest-level trauma center. The goal is to facilitate air medical care when needed, and avoid overutilization when not needed."(13)

The NHTSA report highlights the fact that the current triage system needs help and that there is a need to develop protocols that help distinguish individuals who are likely to have serious injuries from those who do not(13) It has been noted that when viewed from a post-transport perspective, air medical transport over-triage is rampant(14); the costs of over-triage include not only unnecessary monetary expense, but also risk to the crews and opportunity cost of missing a critical transport while transporting a patient for whom air transport provides no benefit.

A 2006 meta-analysis of 22 studies conducted between 1983 and 2004 showed that almost 66% of trauma patients, transported by air medical services to trauma centers, did not have life-threatening injuries.(15)The American College of Surgeons Committee on Trauma has defined acceptable over-triage rates as between 25-50%.(16) Significant over-triage not only represents ineffective use of this resource, but can put patients and crews at unnecessary risk. The Air Medical Physician Association published a safety report in 2002 which showed that the death rate for helicopter medical personnel was 192 per 100,000 compared to a rate of 3.8 per 100,000 for workers in all industries in general.(17)

Identification of factors associated with the appropriate use of air medical transport for trauma victims is the first step in optimizing its use. With the completion of this data collection, we will seek to describe whether those patients who were transported by air to a Level 1 trauma center were appropriately triaged. We anticipate that the information obtained from this study, when it is completed, will assist in the development of more specific guidelines for the efficient use of air medical transport.

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