Center for Translational Injury Research

CeTR

A University Center

Reliable Reduction of Trauma Overtriage Based on Prehospital Data: A Conservation of Scarce Health Care Resources

Michelle Scerbo BS†, Arathi Lakhole MD†*, J. Kent Fite BS†, Jeanette Podbielski RN, BSN†*, Denise Hinds RN †*, Sheila Lopez RN‡, Edmundo Dipasupil‡, Will David RN, BSN‡, Deborah del Junco PhD*, James H. Duke MD†, John B. Holcomb MD†**

***Center for Translational Injury Research, †The University of Texas Health Science Center at Houston, ‡Memorial Hermann Hospital-TMC, Houston, TX**

www.uth.tmc.edu/cetir

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

Background

Fifty percent of the Code 2 patients that arrive to Memorial Houston Hospital-TMC in Houston, TX via helicopter (LF) are discharged after arrival.

Code 2 patients are hemodynamically stable, but have a mechanism of injury (MOI) that could indicate a potentially serious condition (Table 1).

Prehospital triage is currently based on vital signs, MOI and anatomical location of injury.

An overtriage rate of 50% is considered acceptable by the American College of Surgeons Committee on Trauma.

This historic rate, however, contributes to overcrowding and delayed care to the more seriously injured.

This is especially problematic at Memorial Hermann Hospital-TMC, as we are currently receiving ≈600 Code 2 patients a month, 50% of which are discharged home from the Emergency Department (ED). This overtriage is contributing a current 20% diversion rate, which is considerably higher than the recommended <5%.

Hypothesis

We hypothesize that there is a signal within the prehospital physical exam and vital signs, or a derivative of these vital signs, that will differentiate admitted versus discharged Code 2 patients arriving to the ED by helicopter.

Methods

This study was approved by the Institutional Review Board of the University of Texas Health Science Center, Houston, Texas.

A retrospective study of all adult (>18 years) Code 2 patients (n=1758) that arrived to Memorial Hermann Hospital-TMC in Houston, TX via LF was conducted using LF patient records from May 2007 – May 2009.

Due to time constraints, a subset (n=492) of this cohort was analyzed.

The LF patient prehospital record, or "run sheet" was entered into an electronic format from its current hand written format. The data from each sheet was extracted for electronic analysis.

Each patient file was randomly assigned a number to blind the evaluator from the patient's disposition.

Statistical analysis included linear regression and unpaired Student's t-tests. At this point in time, only univariate analysis of vital signs were evaluated to compare the discharged (n=288) and admitted (n=204) groups.

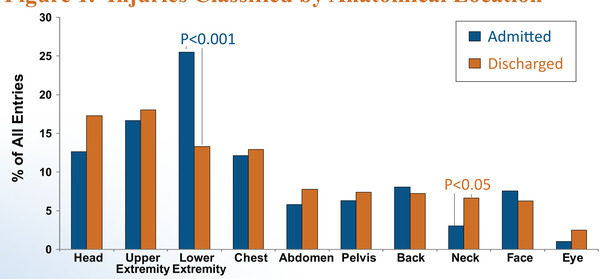
Table 1. Code 2 versus Code 3 Classification Criteria

	Code 2	Code 3
Physiologic Criteria		
GCS	>10, ≤14	≤10
Heart Rate	110 - 120	>120
Systolic Pressure	>90	<90
Respiratory Rate	Not Specified	>29,<10
Intubated	No	Yes
Anatomic Criteria		
Penetrating Injury	To Extremity	Any to torso, groin, head or neck
Amputation	None specified	Proximal to ankle or wrist,
Loss of sensation	None specified	Paraplegia, quadriplegia
Hemorrhage	None specified	Uncontrolled external
Fracture	None specified	Pelvic, Two or more long bone
Trauma with burn	10 - 20% BSA or inhalation injury	≥ 20% BSA
Risk Factors		
Extrication	Any patient requiring extrication	None specified
Intrusion Depth	Into a passenger space of a motor vehicle of > 12"	None specified
Ejection	From an enclosed vehicle, or from motorcycle >20 MPH	None specified
Pregnancy	>20 wks	None specified
Death of occupants	In the same motor vehicle	None specified
Auto vs. pedestrian	Any injury	None specified
High risk	>65 years	None specified
Falls	>15'	None specified
Transfers	None specified	Receiving blood to maintain vital signs
Respiratory	None specified	Compromise/obstruction

Table 2. Cohort Demographics

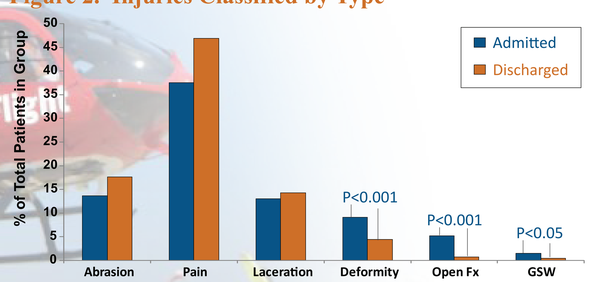
Variable	Cohort	Admitted	Discharged	P value
n	492	204	288	
Age (year)	37 ± 19	39 ± 17	36 ± 20	0.16
Gender				
Male (%)	69	66	71	0.27
Female (%)	31	34	29	
MOI				
Blunt (%)	93	93	93	0.86
Penetrating (%)	4	4	3	0.45
Trauma Detail				
MVC/MCC (%)	67	65	68	0.56
Fall (%)	12	14	11	0.38
Assault/Blunt (%)	2	3	6	0.16
Other (%)	19	18	15	
RTS	7.76 ± 0.35	7.74 ± 0.38	7.76 ± 0.34	0.52
GCS				
Eye	3.88 ± 0.44	3.85 ± 0.48	3.89 ± 0.40	0.33
Verbal	4.6 ± 0.68	4.6 ± 0.65	4.6 ± 0.70	0.68
Motor	5.95 ± 0.37	5.95 ± 0.39	5.95 ± 0.36	0.89
Total	14.4 ± 1.25	14.4 ± 1.3	3.89 ± 0.40	0.81
Correctly classified as Code 2 (%)	75	73	76	0.20
# of Code 2 Criteria met	1.61 ± 0.79	1.72 ± 0.8	1.54 ± 0.72	**0.01**

Figure 1. Injuries Classified by Anatomical Location



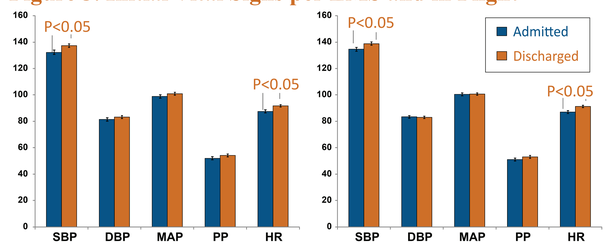
Values are expressed as a percentage of total entries per group (admitted and discharged). For each individual patient, a maximum of four anatomical locations could be indicated. There were more injuries to the lower extremities in the admitted group (P<0.001) while the discharged group had more neck injuries (P<0.05).

Figure 2. Injuries Classified by Type



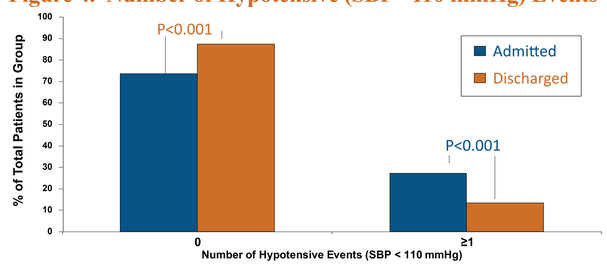
Values are expressed as a percentage of total entries per group (admitted and discharged). For each individual patient, a maximum of three types of injuries could be indicated for each anatomical location. There were more deformities (P<0.001), open fractures (P<0.001) and gun shot wounds (P<0.05) in the admitted versus discharged group.

Figure 3. Initial Vital Signs per EMS and in Flight



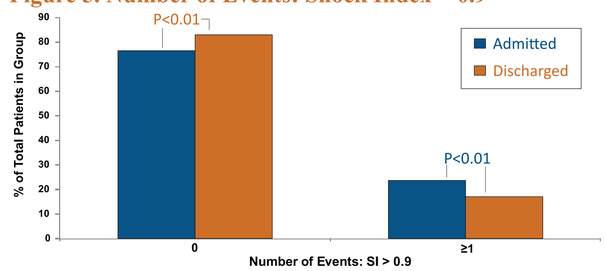
The first set of vital signs obtained by (A) the EMS service and (B) in flight were compared in the admitted and discharged groups. Systolic Blood Pressure (SBP) and Heart Rate (HR) were higher in the discharged group both as reported by the EMS service and in flight (P<0.05).

Figure 4. Number of Hypotensive (SBP <110 mmHg) Events



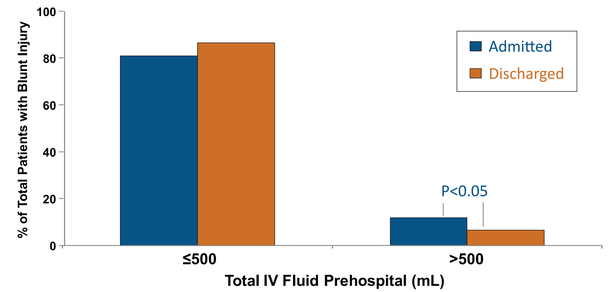
The number of times each individual patient had a hypotensive SBP (<110 mmHg) were tallied and summed. There were more patients in the admitted group that had one or more hypotensive events than in the discharged group (P<0.001). Similarly, there were more patients in the discharged group that had no hypotensive events (P<0.001).

Figure 5. Number of Events: Shock Index > 0.9



Shock Index (SI = HR/SBP) greater than 0.9 has been previously shown to identify patients requiring admission despite stable vitals. The number of times each individual patient had a SI >0.9 prehospital was tallied and summed. There were more patients who had a SI >0.9 one or more times in the admitted group compared to the discharged group (P<0.05). Similarly, there were more patients in the discharged group who never had a SI > 0.9 (P<0.05).

Figure 6. MOI and IV Fluid Volumes - Prehospital



MOI was compared against the volume of fluid administered prehospital. There were twice as many patients who were had a blunt MOI and received more than 500 mL of fluid prehospital in the admitted group compared to the discharged group (P<0.05).

Future Analysis

Using the complete set of prehospital data for 1758 Code 2 patients transported by Life Flight in the time interval May 2007 through May 2008, multivariable logistic regression modeling will be used to identify the factors most strongly associated with ED admission (cases) compared with discharge (controls).

Odds ratios will be calculated with 95% confidence intervals.

The performance of the final model will be assessed with respect to calibration (observed compared with predicted outcomes) and discrimination (the ability to distinguish cases from controls).

Calibration will be evaluated graphically and with the Hosmer-Lemeshow goodness of fit test.

Discrimination will be evaluated by quantifying the area under the receiver operator characteristic (ROC) curve.

The final model will be internally validated using bootstrapping techniques and externally validated by performing logistic modeling using the same set of variables on a naïve data set of Code 2 patients transported by Life Flight in the time interval May 2008 – May 2009.

A combined model using all patient data will also be evaluated.

Conclusions

There are numerical differences, although likely not clinically significant, between the admitted and discharged patient groups.

Based on the current analytic method and cohort size, reliable prediction of admission versus discharge cannot confidently be assessed.

If the planned analysis is not successful, then new monitoring technology may need to be utilized in the prehospital environment.

The University of Texas

Medical School at Houston

A part of The University of Texas Health Science Center at Houston