Abstract

Objective: Helicopter emergency medical services (HEMS) are widely used in regional trauma care and present unique challenges in the patient handoff process. In particular, the practice of patient handoff on the landing zone versus the trauma bay does not exist in ground emergency medical services. We hypothesized that patients handed off on the landing zone versus the trauma bay would have different patient characteristics and outcomes.

Methods: A retrospective review identified 305 HEMS trauma patients received at our level 1 trauma center over a 3-year period. Patients were sorted on the basis of the handoff location, (landing zone vs. trauma bay) and assessed for predictors of injury severity including the Revised Trauma Score, the Injury Severity Score, the Trauma and Injury Severity Score, and other outcomes, primarily mortality.

Results: Of the 305 patients, 235 (77%) were handed off in the bay, and 70 (23%) were not. Regarding the characteristics of patients who were handed off in the bay, they were more likely to have hypotension (100% vs. 73%), have a lower O$_2$ saturation level (97.9 vs. 99.4), and a lower Glasgow Coma Scale at the scene (10.9 vs. 13.9). When controlling for injury severity, the odds of survival for patients who were handed off in the bay were 11.06 times the odds for patients who were not handed off in the bay.

Conclusion: In this limited study, we found that HEMS did identify the sickest patients and brought them to the trauma bay. Despite their greater injury severity, the patients handed off in the bay fared better than those handed off on the landing zone.

Introduction

Helicopter usage for the transportation of traumatic patients has become the standard in regional trauma care and improves patient outcomes. In some regional trauma systems, aircrews always escort the patient to the trauma bay, whereas in others the exchange may take place on the landing zone. Thus, a helicopter crew has a choice to make with regards to the location of the handoff of a trauma victim. They can choose the rapid but less controlled environment of the landing zone or take the patient to the emergency department (ED), which has a longer turnaround time. On the landing zone, the trauma attending may not be present, there is no written documentation at that moment, and conditions are less than ideal for hearing the report. Interviews with flight crews cite that decisions about the location of patient turnover are based on incoming weather that might ground the helicopter at the hospital and turnaround time when the crew has several assignments waiting in the queue, all of which are balanced against the severity of patient injury. Although weather and turnaround times are often outside the crews’ control, judging injury severity is their forte. There are several scoring systems to evaluate injury severity during ground transportation, but paramedic judgment provides similar results. With proper patient handoffs in the medical setting being a national safety goal, the choice of the air medical handoff location needs to be standardized. Previous studies have shown that ambulance handoffs in the trauma bay often fail to convey critical information. It is probable that handoffs on a helicopter landing zone are even more problematic.

Methods

This study was approved by the institutional review board. This was a 3-year (November 20, 2007, through November 2, 2010) retrospective cohort study of our prehospital electronic medical records (emsCharts, West Mifflin, PA), which were sorted on the basis of the handoff location (ie, helipad vs. trauma bay). Our primary endpoints were the Injury Severity Score (ISS), the Glasgow Coma Scale (GCS) score at the scene, upon arrival at the ED, and at discharge; systolic blood pressure; diastolic blood pressure; the oxygen saturation level at the scene; the presence of hypotension; age; the mechanism of injury; the number of preexisting diseases, the death of another passenger in the accident; crash speed/fall height; intrusion; extrication time; the end-tidal carbon dioxide level; prehospital intubation; the heart rate at the scene;
the respiratory rate at the scene; the Revised Trauma Score (RTS) at the scene; Trauma and Injury Severity Score (TRISS); and the anatomic locations of injury. Hypotension was defined as any systolic blood pressure less than 90 mm Hg en route to the trauma center, discharge status (ie, dead or alive), and the GCS score at discharge. Information was obtained from our electronic medical records (emsCharts) by performing a query for all traumas received by our hospital by helicopter over the study period. A similar query was made of the hospital’s trauma registry, and those charts were matched with electronic medical record endpoints. The charts were then divided into 2 groups based on the handoff location. Patients were included if they were brought in by helicopter to our regional trauma center. Interfacility transports were excluded.

New Jersey has 2 state police helicopters and 3 private helicopters. Primarily, the state police helicopter brings 911 patients to the trauma center. This study was conducted at an American College of Surgeons–verified level 1 trauma center, which is 1 of 3 in the state. The state also has 7 level 2 trauma centers. Our trauma volume is approximately 1,500 patients per year, with 18% having experienced penetrating trauma. The location of patient turnover is determined solely by the flight crew. All helicopter trauma patients are greeted by a trauma nurse, emergency medical technician, security officer, midlevel surgical resident, and surgical intern.

Frequencies for all data describing the patient ED visit were calculated by whether the patient was handed off in the bay or not (yes/no). Potential confounders were identified as those significantly associated with handoff as determined by a Fisher exact test in the case of binary variables and an exact chi-square test for variables with more than 2 categories. If at least 1 level of a potential confounder had less than 5 patients handed off in the bay or 5 not handed off in the bay, these covariates were noted as not having a sufficient sample size for comparing the variable of interest (ie, handoff in the bay) across all covariate levels. Thus, further analyses were conducted using the total population and restricting analyses to only those categories of the noted covariates with a sufficient sample size for comparing handoff in the bay versus not. A backwards stepwise logistic regression with whether the patient was discharged alive as the response was then used to select other potential confounders for the final analysis.

In the final analysis, tables stratified by the selected confounder(s) were constructed to examine the relationship between being discharged alive (yes/no) and handoff in the bay (yes/no). Logistic regression was used to assess the significance of the effect of handoff in the bay. A Wald test was used to assess significance, and the common odds ratio was estimated based on the estimated regression coefficient. These analyses were conducted for all subjects and the restricted sample.

**Results**

Frequencies for all patient data describing the patient ED visit stratified by whether the patient was handed off in the bay or not (yes/no) are included in Table 1. There were 305 patients, 235 (77%) of whom were handed off in the bay and 70 (23%) were not. Patients who were handed off in the bay were more likely to have hypotension (100% vs. 73%, \( P < .0001 \)); a lower \( O_2 \) saturation level (means of 97.9 vs. 99.4, \( P = .0265 \)); a lower GCS score at the scene, upon arrival at the ED, and at discharge (means of 10.9 vs. 13.9, \( P < .0001 \); 10.3 vs. 14.4, \( P < .0001 \); and 14.5 vs. 14.9, \( P = .0039 \), respectively); a lower RTS on the scene (means of 10.3 vs. 11.7, \( P < .0001 \)); a higher ISS (means of 18.3 vs. 11.6, \( P < .0001 \)); and a lower TRISS (means of 0.80 vs. 0.97, \( P < .0001 \)). There were less than 10 patients not handed off in the bay who had hypotension, were intubated at the scene, or were involved in an accident in which there was a death of another passenger.

**Discussion**

Our study has several limitations. This was a single-institution study at 1 of 3 level 1 trauma centers in our state, and, therefore, extrapolations can only be made to similar settings. The data entered by the prehospital care providers may have had some slight inaccuracies. The information obtained from the Access (EMSCharts, Pittsburgh, PA) databases was entered during emergency situations when time was limited and, therefore, could have potentially resulted in reporting errors. Some discrepancies were identified when matching patients between databases, including errors in spelling and dates. The data were thoroughly reviewed to identify these errors, but...
the possibility exists that not all were detected. Additionally, this study was conducted retrospectively. Therefore, no cause-and-effect relationships could be established. Although associations were found between patient treatment groups, there exists the possibility that these may be caused by confounding variables.

Although national guidelines exist, it is the authors’ experience that patients who are brought to the trauma centers by air may or may not meet the criteria. Additionally, because this was retrospective data, we did not have information regarding rationale that the crew used when deciding if they should come to the trauma bay with the patient. Perhaps other factors were used that were not accounted for such as the experience of the crew, the time to the end of the shift, and the desire of the pilot.

To our knowledge, this is the first study in the literature that evaluates the status of trauma patients who are handed off in the ED versus the landing zone. The transfer of patient care has become increasingly important since the Institute of Medicine reports identifying that this is a critical period that poses an increased risk to patient safety.

A helicopter ambulance crew has a choice to make with regards to the location of the handoff of a trauma victim. They can choose the rapid but less controlled environment of

Table 1. Descriptives: Either Frequencies (%) or Means (Standard Deviations) of Variables by Handoff Category

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>Total N</th>
<th>Yes (n = 235)</th>
<th>No (n = 70)</th>
<th>P value for difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge alive</td>
<td>Yes</td>
<td>264</td>
<td>199 (75%)</td>
<td>65 (25%)</td>
<td>.1086</td>
</tr>
<tr>
<td>Death of another passenger</td>
<td>Yes</td>
<td>7</td>
<td>5 (71%)</td>
<td>2 (29%)</td>
<td>.6622</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Yes</td>
<td>28</td>
<td>28 (100%)</td>
<td>0 (0%)</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Penetrating trauma</td>
<td>Yes</td>
<td>29</td>
<td>25 (86%)</td>
<td>4 (14%)</td>
<td>.2547</td>
</tr>
<tr>
<td>Intubated at scene</td>
<td>Yes</td>
<td>8</td>
<td>7 (88%)</td>
<td>1 (13%)</td>
<td>.6869</td>
</tr>
<tr>
<td>Number of preexisting conditions</td>
<td>0</td>
<td>141</td>
<td>101 (72%)</td>
<td>40 (28%)</td>
<td>.3173</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>66</td>
<td>50 (76%)</td>
<td>16 (24%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>31</td>
<td>27 (87%)</td>
<td>4 (13%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
<td>5 (83%)</td>
<td>1 (17%)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>305</td>
<td>38.3 (19.7)</td>
<td>36.6 (20.4)</td>
<td>.5355</td>
</tr>
<tr>
<td>Respiration rate at the scene</td>
<td></td>
<td>295</td>
<td>17.2 (6.9)</td>
<td>18.1 (3.8)</td>
<td>.1656</td>
</tr>
<tr>
<td>Pulse at the scene</td>
<td></td>
<td>299</td>
<td>95.1 (24.5)</td>
<td>92.8 (15.2)</td>
<td>.3427</td>
</tr>
<tr>
<td>Blood pressure at the scene</td>
<td></td>
<td>293</td>
<td>123.8 (37.5)</td>
<td>136.0 (23.6)</td>
<td>.0016</td>
</tr>
<tr>
<td>O2 saturation</td>
<td></td>
<td>278</td>
<td>97.9 (9.9)</td>
<td>99.4 (1.0)</td>
<td>.0265</td>
</tr>
<tr>
<td>GCS at the scene</td>
<td></td>
<td>299</td>
<td>10.9 (5.0)</td>
<td>13.9 (3.0)</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>GCS in the ED</td>
<td></td>
<td>304</td>
<td>10.3 (5.7)</td>
<td>14.4 (2.2)</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>GCS at discharge</td>
<td></td>
<td>264</td>
<td>14.5 (1.9)</td>
<td>14.9 (2.5)</td>
<td>.0039</td>
</tr>
<tr>
<td>RTS on the scene</td>
<td></td>
<td>290</td>
<td>10.3 (2.8)</td>
<td>11.7 (1.4)</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>ISS</td>
<td></td>
<td>302</td>
<td>18.3 (12.3)</td>
<td>11.6 (8.3)</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>TRISS</td>
<td></td>
<td>281</td>
<td>0.80 (0.30)</td>
<td>0.97 (0.06)</td>
<td>&lt; .0001</td>
</tr>
</tbody>
</table>

P values were determined by the Fisher exact test when the variable was binary, an exact chi-square test when the variable was nominal with more than 2 categories, and by a 2-group t-test allowing for unequal variances when the variable was continuous.
the landing zone or the formal environment of the trauma bay. In this retrospective analysis, we sought to determine characteristics and outcome measures of patients handed off to the trauma team on the helipad versus the trauma bay. No protocol existed during the study period, and, subsequently, it was solely the decision of the air medical team. The first step to creating a national decision rule is to examine the data and further study the protocol call prospectively. This study represents the first part of this process.

More critical patients were brought down to the ED. In fact, less than 10 patients in this study who were critical by the GCS, blood pressure, or oxygen saturation level were handed off on the helipad. All patients who were hypotensive were handed off in the ED. The 3 determining factors were blood pressure, the GCS, and the oxygen saturation level. Even though they were a sick population (ISS: 18.3 vs. 11.6), the odds of survival were better for patients handed off in the ED. The odds of survival for all patients who were handed off in the ED were 2.73 times the odds for patients who were not handed off in the ED. This difference grew to 11 times in some subgroups with a very low GCS score of 3.

It is difficult to pinpoint the exact reason for this; however, it raises an important question. Should all patients, regardless of their presumed severity of injury, be handed off in the ED trauma bay as opposed to at the landing zone? It may be reasonable to suggest this change without knowing exactly why these patients did better when handed off in the bay because an 11 times greater survival rate should not be ignored. One could speculate that despite testing well in identifying the sickest patients, some patients are missed by HEMS or do not appear as sick as they actually are. To avoid this discrepancy and its potentially serious sequelae, it may be better to hand off all patients in the ED trauma bay.

This study establishes the first effort proposing standardization in bringing patients into the trauma bay, and it raises many questions that require further study. How prevalent is the practice of landing zone handoff? Was location a causal factor in patient outcome, and, if so, what specific factors differentiate the landing zone from the trauma bay? As these questions are answered, we may move to a standardized model for patient turnover.

### References


<table>
<thead>
<tr>
<th>Population</th>
<th>GCS category</th>
<th>Handoff in bay</th>
<th>Common odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>3</td>
<td>51/51 = 100%</td>
<td>33/34 = 97%</td>
<td>2.73</td>
</tr>
<tr>
<td>4-14</td>
<td>23/32 = 72%</td>
<td>0/2 = 0%</td>
<td>(0.73-10.22)</td>
<td>.1358</td>
</tr>
<tr>
<td>15</td>
<td>125/181 = 69%</td>
<td>3/5 = 60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No intubation at scene, death of other passenger, or hypotension</td>
<td>3</td>
<td>41/41 = 100%</td>
<td>17/18 = 94%</td>
<td>11.06</td>
</tr>
<tr>
<td>4-14</td>
<td>19/28 = 68%</td>
<td>0/1 = 0%</td>
<td>(1.31-93.71)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>106/160 = 66%</td>
<td>0/2 = 0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Determined via logistic regression adjusting for GCS category at presentation to the ED.*