# Helicopters and the Civilian Trauma System: National Utilization Patterns Demonstrate Improved Outcomes After Traumatic Injury

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**Background:** The role of helicopter transport (HT) in civilian trauma care remains controversial. The objective of this study was to compare patient outcomes after transport from the scene of injury by HT and ground transport using a national patient sample.

**Methods:** Patients transported from the scene of injury by HT or ground transport in 2007 were identified using the National Trauma Databank version 8. Injury severity, utilization of hospital resources, and outcomes were compared. Stepwise logistic regression was used to determine whether transport modality was a predictor of survival or discharge to home after adjusting for covariates.

**Results:** There were 258,387 patients transported by helicopter (16%) or ground (84%). Mean Injury Severity Score was higher in HT patients ($15.9 \pm 12.3$ vs. $10.2 \pm 9.5$, $p < 0.01$), as was the percentage of patients with Injury Severity Score >15 (42.6% vs. 20.8%; odds ratio [OR], 2.83; 95% confidence interval [CI], 2.76–2.89). HT patients had higher rates of intensive care unit admission (43.5% vs. 22.9%; OR, 2.58; 95% CI, 2.53–2.64) and mechanical ventilation (20.8% vs. 7.4%; OR, 3.30; 95% CI, 3.21–3.40). HT was a predictor of survival (OR, 1.22; 95% CI, 1.17–1.27) and discharge to home (OR, 1.05; 95% CI, 1.02–1.07) after adjustment for covariates.

**Conclusions:** Trauma patients transported by helicopter were more severely injured, had longer transport times, and required more hospital resources than those transported by ground. Despite this, HT patients were more likely to survive and were more likely to be discharged home after treatment when compared with those transported by ground. Despite concerns regarding helicopter utilization in the civilian setting, this study shows that HT has merit and impacts outcome.

**Key Words:** Helicopter utilization, Trauma systems, Injury severity, Outcomes, National Trauma Databank.

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Helicopter transport (HT) of the injured patient has been an integral component of trauma care in the United States since the 1970s, due in large part to the military aeromedical experience.[1] The ability to transport a trauma patient from the scene of injury to a facility where definitive care can be provided in a timely fashion remains a core objective in the management of the severely injured patient. In fact, the availability of helicopters in this setting has been credited with improving trauma center access for a significant percentage of the US population.[2] Furthermore, the relationship between delay in timely access to definitive care and mortality has been well documented.[3]

Despite these considerations, HT in the civilian trauma population remains controversial. Concerns over safety as well as appropriate use of this costly and limited resource continue to challenge the role of helicopters in modern trauma care.[4] Some have asserted that HT is over used and others have questioned its benefits[5]; however, previous studies looking at this issue have been limited by small patient populations, relying on single center or meta-analysis design. The objective of this study was to compare outcomes between HT and conventional ground transport (GT) of injured patients from the scene of injury using a national trauma patient population.

## PATIENTS AND METHODS

Patients transported directly to a trauma center from the scene of injury by helicopter or by ground ambulance and admitted in 2007 were identified using the National Trauma Databank (NTDB) version 8. This is the first version of the NTDB data set that includes transport modality. Interfacility transfer patients were excluded. Patients who were dead on arrival (DOA) were also excluded; however, a subgroup analysis was conducted to assess the significance of DOA subjects in both the HT and GT groups.

Data collected for each patient included age, gender, mechanism of injury, prehospital times (response, scene, and total times), Injury Severity Score (ISS), Glasgow Coma Scale score, admission systolic blood pressure, admission respiratory rate (RR), length of stay (LOS), intensive care unit (ICU) admission and LOS, mechanical ventilation and ventilator days, emergency department disposition, hospital disposition, trauma center designation, and insurance status. Prehospital transport time was calculated as total prehospital time − prehospital response and scene times. Because helicopters are able to travel in a straight-line, direct path at a relatively constant speed, an estimate of transport distance was derived using the transport time and an assumed average transport speed of 150 mph based on industry standards.[1] Insurance status was dichotomized as insured (commercial,

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auto, and workers compensation) versus uninsured (self pay, none, and subsidized).

Demographics, prehospital times, and indicators of injury severity as well as hospital resource utilization were compared between HT and GT groups including mean ISS, severe injury (ISS >15), severe head injury (Glasgow Coma Scale score ≤8), hypotension (systolic blood pressure <90 mm Hg), abnormal RR (<10 or >29 bpm), LOS, need for ICU admission, ICU LOS, need for mechanical ventilation, ventilator days, need for emergent operation defined as an emergency department disposition to the operating room, and proportion of subjects discharged alive within 24 hours of arrival at the trauma center.

The main outcome evaluated between HT and GT subjects was survival to discharge. Outcomes were compared in both univariate and multivariate regression analysis. A forward stepwise logistic regression model was used to determine whether transport modality was an independent predictor of survival while adjusting for the following covariates: age older than 55 years, gender, mechanism, ISS >15, hypotension, severe head injury, abnormal RR, mechanical ventilation, emergent operation, ICU admission, trauma center designation, and insurance status. Each covariate was tested in univariate analysis in a forward stepwise fashion for association with survival. Covariates were included in the model if associated with survival at a level of $p < 0.2$.

Data analysis was conducted using SAS JMP version 7.0 (Cary, NC). During univariate analysis, $\chi^2$ tests were used to compare categorical variables, and nonparametric Mann-Whitney $U$ tests were used to compare continuous variables. Continuous data are presented as mean ± SD. A $p$ value ≤0.05 was considered significant after stepwise multivariate logistic regression with adjusted odds ratio (OR) and 95% confidence interval (CI) calculations to determine independent predictors of survival. This study was approved by the University of Rochester Research Subjects Review Board.

## RESULTS

Analysis of the NTDB population identified 258,387 subjects transported by either helicopter (16%) or ground ambulance (84%) (Fig. 1). HT subjects were younger (36 years ± 19 years vs. 42 years ± 22 years; $p < 0.01$), more likely to be male (70% vs. 65%; $p < 0.01$), and more likely to have a blunt mechanism (93% vs. 88%; $p < 0.01$) when compared with GT subjects.

Of the DOA subjects, 78 were in the HT group and 524 were in the GT group, representing 0.2% of each group. Mean ISS for DOA subjects was similar between HT and GT groups (31 ± 20 vs. 32 ± 24, $p = 0.5$), and mean transport time was longer in the HT group (19 ± 9 vs. 12 ± 8, $p < 0.01$). For every DOA subject in the HT group, there were 498 survivors compared with 395 survivors for every DOA subject in the GT group.

When comparing indicators of injury severity, patients transported by helicopter were more severely injured (mean ISS and percentage with ISS >15), were more likely to have a severe head injury, and were more likely to have documented hypotension or abnormal RR when compared with those transported by ground ambulance (Table 1). Furthermore, HT subjects also had longer LOS, higher rates for ICU admission, and mechanical ventilation, as well as an increased requirement for emergent surgical intervention (Table 2). Only 14.7% of HT subjects versus 25% of GT subjects were discharged alive within 24 hours of admission to the hospital (OR, 0.52; 95% CI, 0.50–0.53; $p < 0.01$).

Response time (19 minutes ± 11 minutes vs. 8 minutes ± 7 minutes; $p < 0.01$) and scene time (17 minutes ± 12

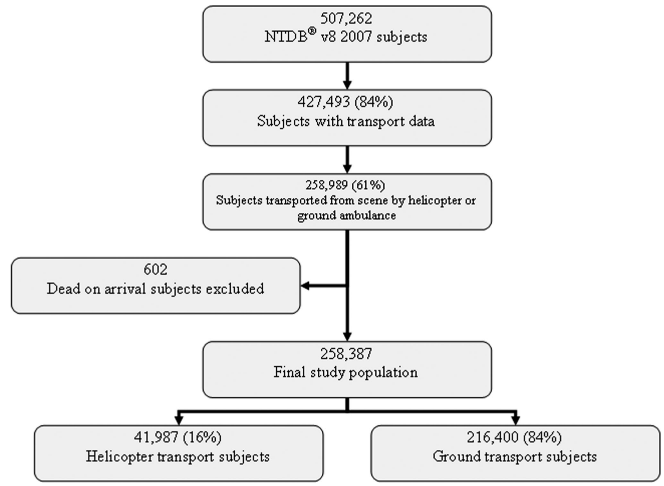


**Figure 1.** Study population by transport modality; National Trauma Databank version 8, admission year 2007.

**TABLE 1.** Comparison of Injury Severity in Helicopter and Ground Subjects

| | Helicopter (n = 41,987) | Ground (n = 216,400) | $p$ | Odds Ratio (95% CI) |
|---|---|---|---|---|
| ISS (mean ± SD) | 15.9 ± 12.3 | 10.2 ± 9.5 | <0.01 | — |
| ISS >15 (%) | 42.6 | 20.8 | <0.01 | 2.83 (2.76–2.89) |
| GCS ≤8 (%) | 19.4 | 6.9 | <0.01 | 3.26 (3.15–3.36) |
| SBP <90 (%) | 4.8 | 3.4 | <0.01 | 1.45 (1.38–1.52) |
| RR <10 or >29 (%) | 11 | 4.9 | <0.01 | 2.44 (2.35–2.53) |

GCS, Glasgow Coma Score; SBP, systolic blood pressure.

**TABLE 2.** Comparison of Hospital Resources in Helicopter and Ground Subjects

| | Helicopter (n = 41,987) | Ground (n = 216,400) | $p$ | Odds Ratio (95% CI) |
|---|---|---|---|---|
| LOS (days ± SD) | 8.5 ± 12.6 | 5.4 ± 8.6 | <0.01 | — |
| ICU admission (%) | 43.5 | 22.9 | <0.01 | 2.58 (2.53–2.64) |
| ICU LOS (days ± SD) | 7.3 ± 10.3 | 5.4 ± 8.6 | <0.01 | — |
| Ventilated (%) | 20.8 | 7.4 | <0.01 | 3.30 (3.21–3.40) |
| Ventilator days (days ± SD) | 7.6 ± 10.6 | 6.5 ± 10 | <0.01 | — |
| Emergent OR (%) | 18.9 | 12.7 | <0.01 | 1.60 (1.56–1.65) |

OR, operating room.

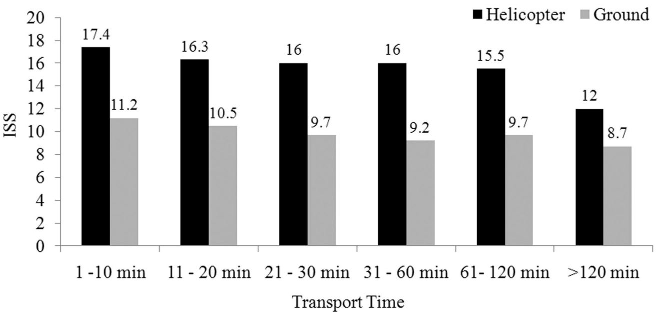


**Figure 2.** Comparison of mean ISS between helicopter and ground transports by transport times.

**TABLE 3.** Regression Results for Survival to Discharge

| Parameter | Adjusted Odds Ratio | Confidence Interval | *p* |
|---|---|---|---|
| Helicopter transport | 1.22 | 1.18–1.27 | <0.01 |
| ISS <15 | 3.01 | 2.89–3.14 | <0.01 |
| Age <55 | 2.14 | 2.06–2.23 | <0.01 |
| Female gender | 1.09 | 1.05–1.13 | <0.01 |
| Penetrating injury | 0.55 | 0.53–0.58 | <0.01 |
| No emergent operation | 1.11 | 1.07–1.16 | <0.01 |
| No ICU admission | 0.70 | 0.67–0.72 | <0.01 |
| No hypotension | 2.27 | 2.18–2.38 | <0.01 |
| No abnormal RR | 1.39 | 1.33–1.45 | <0.01 |
| No severe head injury | 4.20 | 4.04–4.37 | <0.01 |
| No ventilation | 1.31 | 1.26–1.36 | <0.01 |
| Level I trauma center | 1.03 | 1.01–1.07 | 0.05 |
| Insured | 1.22 | 1.18–1.26 | <0.01 |

minutes vs. 16 minutes ± 9 minutes; $p = 0.01$) were both longer for the HT group when compared with GT. Transport time was also longer for HT subjects when compared with those transported by ground (23 minutes ± 13 minutes vs. 19 minutes ± 14 minutes; $p < 0.01$). The average distance for HT, assuming an average transport speed of 150 mph, was 57 miles ± 32 miles. There was an inverse relationship between mean ISS and transport time in both the HT and GT groups; however, the drop-off in ISS over increasing transport times was greater in the HT group than the GT group (Fig. 2).

Overall survival was lower in HT subjects versus GT subjects on univariate analysis (92.5% vs. 95.6%; $p < 0.01$). Stepwise univariate analysis identified all covariates for inclusion in the regression model (Table 3). HT became an independent predictor of survival when compared with GT after adjustment for covariates (OR, 1.22; 95% CI, 1.18–1.27; $p < 0.01$).

## DISCUSSION

The principle that time from injury to definitive care is a critical factor in the survival of severely injured patients drives the perceived benefit of HT. Because helicopters are capable of higher speeds over longer distances without regard to difficult terrain, they can potentially afford an injured patient an improved survival advantage compared with GT modalities. Several early studies of HT from the scene of injury demonstrated reductions in mortality. Baxt and Moody[6] found a 52% mortality reduction comparing HT and GT cohorts using predicted and actual deaths. The same group also noted a 9% mortality reduction of patients with severe head injury transported by helicopter,[7] as well as a mortality benefit using probability of survival in a multicenter study of HT.[8] Additional studies have reported that injury severity impacts the potential benefit of HT.[1,9] A more recent multicenter trial by Thomas et al.[10] reported a 24% mortality reduction for blunt HT patients compared with GT after adjusting for injury and hospital factors. Biewener et al.[11] demonstrated a nearly 50% mortality reduction in HT patients, attributing the benefit to direct transport to a trauma center in patients who would have otherwise been transported by ground ambulance to a nontrauma center.

Conversely, other authors were not able to demonstrate improved outcomes for HT, and recent studies raise the concern that many HT patients are not severely injured. HT utilization in the urban setting received early criticism, when Schiller et al.[12] failed to find a survival difference between blunt HT and GT patients. Subsequent studies in the urban setting have also been unable to illustrate any benefit for HT patients, citing the advanced prehospital care systems and shorter transport times often encountered in urban areas.[13,14] Brathwaite et al.[9] compared HT with advanced life support GT in a statewide system using logistic regression and failed to identify HT as an independent predictor of survival, although the data suggested that patients with ISS 16 to 60 may derive benefit. Cunningham et al.[1] similarly examined a statewide data set where regression analysis did not demonstrate HT to be a predictor of survival, despite identifying a benefit for a subset of patients based on ISS and trauma score.

Some authors have suggested that a significant percentage of patients undergoing HT have relatively minor injuries as a result of over-triage.[9] A meta-analysis by Bledsoe et al.[5] of 22 studies reported that one in four HT patients are discharged within 24 hours of arrival to the trauma center, and between 60% and 70% had non-life-threatening injuries by ISS, trauma score, or probability of survival criteria. These findings coupled with growing safety concerns highlighted by the recent rise in aeromedical helicopter crashes[4] have led several authors to question the role of HT in the civilian trauma population.

This study is the first one to examine the role of HT on a national level, and it includes the largest number of HT patients published in a single analysis. When comparing markers of injury severity for HT and GT patients, ISS was significantly higher and patients with an ISS >15 were nearly three times more likely to be in the HT group. Approximately 43% of HT patients had an ISS >15, much higher than the proportion reported in prior studies.[14–16] HT patients were also more likely to have severe head injuries and abnormal presenting physiology.

When comparing the utilization of hospital resources, HT patients required a higher level of care, including longer hospital and ICU LOS, higher utilization of ICU resources, and a higher requirement for emergent surgical procedures.

Overall, almost half of the HT cohort required ICU admission, one-fifth required mechanical ventilation for an average of 1 week, and nearly one-fifth required an emergent operation. This suggests that, on a national level, patients being selected for HT are appropriately sicker and are more likely to use trauma center resources than those transported by ground ambulance.

It is interesting to note that 57% of patients in the HT group have an ISS $\leq$15, which is similar to the 60% reported in a meta-analysis of scene HT.[5] This implies that over-triage is an issue that continues to impact aeromedical helicopter utilization. However, with this study design, it is difficult to explore this more closely because significant regional variability in HT dispatch criteria undoubtedly exists across the United States. Early reports demonstrated a relatively high ISS of HT patients (mean ISS of 36)[17]; however, more recent studies, including the current one, have reported a mean ISS of HT patients between 16 and 19.[1,9] Furthermore, over triage was found to incrementally increase with time over a 9-year period in one study, and the authors suggested that competition among HT services may play a role as the industry expands.[18] Others have added that the perceived benefit of HT by emergency medical providers may lower the threshold for scene personnel to request a helicopter based solely on mechanism of injury criteria rather than actual injuries or physiologic criteria.[14] Other authors have suggested that mechanism criteria should not be used for helicopter utilization decisions.[19] It is apparent in this study that injury severity drops off more drastically for helicopter than GTs as the transport time increases. This implies that other factors such as distance or geography rather than injury severity alone may play a role in the decision to use HT.

However, this study does show that <15% of HT patients nationally are discharged within 24 hours. This is much lower than the 24.1% reported by Bledsoe et al.,[5] suggesting that the degree of over-triage may not be as significant on the national level as reported in smaller studies. Finally, the Air Medical Physician Association notes the limitations of retrospective injury scoring systems to determine appropriate aeromedical helicopter use, because it fails to acknowledge regional, environmental, and situational factors that play into the decision to use HT.[20]

Despite a lower overall survival when compared with GT, HT was associated with survival to discharge after adjusting for patient, injury, and hospital covariates. There are at least three potential explanations for these observations.

First, as noted above, is the quick transport to definitive care in time-sensitive clinical situations. HT had an average transport time of 4 minutes longer than GT; however, because of the differences in traveling speed, the distances traveled by HT patients were likely to be significantly greater. In this situation, a severely injured patient must be far enough from a trauma center that HT would afford an advantage over conventional GT. Diaz et al.[21] were able to show that HT was faster than GT if simultaneously launched for a patient 10 miles from the trauma center and if requested by scene personnel for a patient 45 miles from the trauma center. Because simultaneous launch is likely to lead to significant over-triage, critically injured patients in the range of 45 miles from the trauma center would likely benefit from HT, which is consistent with the estimated average transport distance of 57 miles seen in this study. This may also suggest that current HT dispatch protocols are being appropriately used.

Second, aeromedical crews may provide a higher level of care in some systems than ground ambulance crews for two potential reasons. First, helicopter providers may be trained and authorized to perform potentially lifesaving interventions such as rapid sequence intubation, cricothyroidotomy, or blood product administration that ground crews cannot.[22] In addition, helicopter crews are more likely to have exposure to a larger volume of trauma patients, affording them an increased level of experience and comfort with management of the severely injured patient. Thomas et al.[10] demonstrated this principle in the 98% success rate of airway interventions performed by aeromedical providers over a 6-year period.

Finally, HT may have utility over terrain where ground ambulances cannot or would have extreme difficulty accessing. This is likely the least common situation in which HT may confer benefit; however, given the national data included in the study, there are certainly areas of the country where this potential benefit of HT may play a role.

This study must be interpreted in light of its methodological limitations. First are those inherent to a retrospective design. Second are those outlined by the American College of Surgeons Committee on Trauma for use of the NTDB.[23] The main advantage of the NTDB is the access afforded to a large number of patients in a national sample; however, the caveat is the limited number of variables and detail of information accessible for analysis. This limits the type of data that can be used in regression modeling to control for potential confounders, as well as the outcomes that can be examined. The large number of subjects in this study permits detection of small differences, particularly in the overall survival between the groups. However, this small statistically significant difference is of unclear clinical significance and requires further investigation. In addition, it is not possible to evaluate the multitude of factors that drive the individual decisions to transport a patient by helicopter in each and every case. The estimated distance for HT is based on the assumption of straight flight path with constant flight speed during transport to the trauma center, which is plausible in helicopter flight, although this may have been affected by factors such as weather and geography. Furthermore, these assumptions are not true for GTs, thus estimated distances could not be reliably calculated from transport time and did not permit a comparison between HT and GT. Finally, the heterogeneity of the dataset limits specific conclusions that may be drawn or applied to any individual trauma system.

This unique analysis of national helicopter utilization shows that HT patients are more severely injured and use more hospital resources than GT patients. HT was found to be an independent predictor of survival after adjusting for patient, injury, and hospital-level variables. Although over-triage continues to be an issue requiring attention by individual trauma systems, it may not be as profound as previously reported. Despite concerns regarding helicopter utilization in the civilian setting, this study shows that HT has merit and impacts outcome. Further analysis within regional trauma systems is warranted to explore factors that may help to explain the mortality benefit seen in this study.

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## DISCUSSION

**Dr. Alexander Eastman** (Dallas, Texas): Good morning. I would also like to thank the Association for the privilege of the floor this morning. While many, many things have changed in the modern paradigm of the care of the injured, rapid, efficient transport of the injured patient to a center that is capable of providing optimal life-saving treatment remains one of our most sacred tenets.

This goal, reinforced by striking reductions in casualty mortality during Korea, Vietnam, and now our latest conflicts, remains the goal of nearly every organized trauma system. It is clear, given this goal, that the use of helicopter transport is a vital life-saving tool in some settings. However, as with many techniques we as trauma surgeons have endorsed over the years, the question remains as to whether while some is good, is even more better?

In this paper, the group from Rochester has mined the National Trauma Data Bank in an attempt to help us continue to assess our use of aeromedical evacuation in today's trauma systems. While overall survival was lower in their helicopter transport group, their elegant regression analysis identified helicopter transport as an independent predictor of both survival to hospital discharge as well as discharge to home.

Whether this benefit is due to the improved prowess of our helicopter crews, as you suggest in the manuscript, or the improved care provided at the destination centers is still a matter of ongoing debate that cannot be answered here. Nonetheless, this well-written paper will add to our body of literature in support of the use of helicopter transport.

However, despite the findings we've just heard, we're far from optimizing the use of this expensive, finite resource and we still lack definitive, evidence-based guidelines for where and when to endorse the use of helicopter transport of the injured.

The authors correctly point out that most studies in urban environments, as well as those in areas with mature, robust EMS systems have failed to demonstrate any benefit associated with the use of helicopter transport, yet others have seen a mortality benefit in transport solely to Level 1 centers. Additionally, they recognize the problem of over triage, one that any one of us who works in a center that receives even a moderate amount of patients from aeromedical services can attest to as well.

The question is how do we refine what we do now and it is here where I have a few questions for the authors. First, with regards to over triage, my feelings both as a surgeon and an EMS medical director is that we train to correct this problem. What objective criteria, physiologic or otherwise, would you advocate as being an indicator for potential helicopter scene transport, given distance and destination concerns?

 

Second, are there additional skills that you think we can place in the hands of our aeromedical crews that will further enhance their benefit to our patients?

Lastly, and probably most controversial, and so I urge you to tread cautiously, is with your findings and those I mentioned, is it still justifiable to allow our helicopter services to transport injured patients to less than Level 1 centers when the data fairly clearly supports bringing these patients to our top echelon of care?

I thank the authors for the timely submission of their manuscript and applaud you on an excellent and well-presented paper. Thank you for the time.

**Mr. Joshua Brown** (Rochester, New York): Thank you for your kind words and excellent discussion. To address your first question about objective criteria, I think that in terms of training the pre-hospital providers, I think that is where we need to go and there definitely is the perception that the helicopter flies in and saves the day and that's not necessarily based on evidence.

Some of the evidence, I think, does support removing mechanism of injury criteria from the pre-hospital triage for helicopters. The other thing that I would say is I think that there is, in some systems certainly, a culture of anyone being able to request a helicopter transport, sort of based on their suspicion, and I think we need to take that away and leave it up to the leaders on the scene, the EMS highest-ranked individual that's in charge of that scene, to be able to make that decision, because that type of person we can have that interaction with the trauma doctors outside of those scenes and educate them and train them in what's the most effective use of that resource.

In terms of what additional skills the aeromedical crews can have, I think that's a great point, because I think that's one of the difficult things to prove, but probably plays a large role in why people do well in the helicopters.

Helicopter crews are essentially regionalized, because their experience is concentrated on seeing the most severely injured trauma patients and especially when you're talking about fifty-seven miles away from the trauma center it's probably a volunteer ambulance crew with much less experience taking care of that patient.

I think that getting the aeromedical crews more involved with the hospital trauma surgeons and having them come and do some of the ATLS courses and making that a requirement for them – I think that, in addition to their experience, will up the ante for them to be able to take care of these very sick patients.

Then, third, in terms of flying to less than a Level 1, I can tell you that in this study 27 percent of the flown patients went to a Level 2 trauma center and so between Level 1 and 2 trauma centers, that was over 99 percent of helicopter transports and so I do think that flying patients to a Level 2 center can be a viable option, especially when you are looking at it in terms of maximizing access to a trauma center and developing an inclusive trauma system. The helicopters can be a very valuable component that is strategically placed to make sure that the most people have access in a timely fashion to either a Level 1 or 2 trauma center.

**Dr. Jeffrey Salomone** (Atlanta, Georgia): This was a very nice presentation, Josh. My question is, what about the percentages of patients transported to Level 1, Level 2, and Level 3 institutions for both the ground and helicopter transport and how do I know your study doesn't show a selection bias of who is going to a Level 1 and that it's really a surrogate, the helicopter transport is a really a surrogate, for Level 1 treatment compared to Level 2 or Level 3 treatment?

**Mr. Joshua Brown** (Rochester, New York): I can tell you that I looked at this data and so 99 percent, as I mentioned, of helicopter patients went to a Level 1 or Level 2. In the ground transport, 57 percent went to a Level 1 and 36 percent went to a Level 2 and so it a fair minority that went to a Level 3 or Level 4 trauma center in this dataset, but I will also say that the NTDB takes data from trauma centers and so there's definitely that skewing there, because we're not seeing the patients who were transported to non-trauma centers that don't contribute to the NTDB.

In terms of the selection bias, whether this is the effect of making sure this person gets to a Level 1 trauma center, we did try to control for that, using the regression and using the trauma center level as one of our covariates, to attempt to control for that, but that certainly could be a player in this outcome, because I think there's some evidence to support that in other studies as well.

**Dr. Richard Dutton** (Baltimore, Maryland): Since I don't necessarily believe that altitude is magical for trauma patients, I'm trying to figure out why your results are what they are. Is it possible that there is a selection bias in who gets transported at all?

In other words, our ground companies in Baltimore bring us a lot more dead, or nearly dead, people, sometimes from difficult urban violence scenes, and I wonder if that doesn't contaminate the data to some extent. Have you tried to look at patients who were DOA or pronounced very quickly at the trauma center as a bias in your inclusions?

**Mr. Joshua Brown** (Rochester, New York): One of the things we tried to look at was comparing the helicopter and ground patients and seeing if the helicopter patients are actually more severely injured. Sort of the impetus for this was we were seeing a lot of literature saying that the helicopter patients aren't all that injured and because there are safety concerns, should we even be doing this?

I think that we were able to show that the helicopter patients are pretty severely injured and have a lot of problems and end up using trauma center resources.

In terms of the DOAs, one of the reasons that we chose to exclude them is because, one, they were missing a lot of data, but, two, we couldn't piece out whether they were a dead patient that EMS brought in or they died in route in a forty-minute flight and so we tried to eliminate that, but I can also tell you that there was no difference in the proportion of DOAs that were eliminated. It was 0.2 percent in both populations, the helicopter and ground, that ended up being eliminated from that.

**Dr. Mark Hamill** (Syracuse, New York): Nice paper. I have one quick question. Did you consider in your data on load and off load times for the helicopter transports? It's not uncommon when we get multiple injured patients from the same scene that the ground ambulances arrive before the helicopter. Often, ground patients are in the trauma bay five or ten minutes before the helicopter patient arrives. There are two components to this delay. The on scene time is often extended by the need to transport the patient to a secondary location to allow safe on load. In addition, at my facility the off load time is between 5–10 minutes from the time the aircraft lands on the pad until the patient arrives in the trauma bay. These two periods can combine to dramatically extend the helicopter transport times.

**Mr. Joshua Brown** (Rochester, New York): I think that where we looked at the times, definitely there's certainly a lag with the response time, getting the helicopter up in the air, the scene time, and then so the total pre-hospital time does get drawn out with the helicopter, but what we were arguing is that fifteen minutes in the helicopter doesn't equal fifteen minutes in the ground ambulance and especially when you're talking the distances.

I think that's where helicopters have the benefit and there's definitely – In reviewing the literature, there has been very little to support the use of helicopters within an urban environment, where the transport times are lower, and so I think the distance, in addition to the injury severity, has to play into our concept of over triage and how to use this limited and costly resource.