Do Trauma Patients Age 55 And Older Benefit From Air Medical Transport?

Howard A. Werman, MD[1], Michael T. Cudnik, MD[2], Subrahmanyam Darbha, MS[3], Jeffrey M. Caterino, MD[1], [1] Department of Emergency Medicine, The Ohio State University, Columbus, OH; [2] Mid Ohio Emergency Services, LLC, Columbus, OH; [3]

Introduction

Air medical transport has been shown to improve outcomes in selected trauma patients.[1-4] Often, this comes at the expense of significant over-triage. As many as 60% of patients transported by air have been shown to derive no benefit from direct transport to a trauma center.[5] While studies have shown that there is an overall positive cost/benefit analysis in trauma victims[6,7], efforts must focus on reduction of inappropriate use of air transport in patients who clearly show no benefit to such transport. This is particularly true when consideration is given to both the high cost and safety risks associated with air medical transport.

A recent analysis of the National Sample Project demonstrated that the mortality benefits of air medical transport do not extend to patients age 55 or older.[8] To our knowledge, this is the first study to demonstrate an age at which air transport no longer provides benefit. If validated, this suggests that patients in this age range who suffer from traumatic injuries may be more appropriately transported by less costly ground services.

Objectives: The purpose of the current investigation was to evaluate mortality benefits of air transport in adult trauma patients ≥ 55 years of age.

Methods: We performed a retrospective analysis of Central Ohio Trauma Registry patients ≥ 55 years of age transported to a trauma center from Jan. 1, 2005 to Dec. 31, 2011. The Central Ohio Trauma System has maintained a voluntary trauma registry since 1999. The Central Ohio Trauma System consists of 27 hospitals covering twenty counties in central and southeastern Ohio. Ohio law mandates that hospitals report specified trauma data to the Ohio Trauma Registry (OTR). COTS Registry has incorporated all the data elements required by the OTR with the addition of a few additional data elements in order to gain an accurate picture of trauma specific to the Central Ohio region. The registry has a full time data registrar and forwards its data annually to the National Trauma Data Bank.

All adult patients greater than age 55 years directly transported from a trauma scene to a Level I or II facility were included in the analysis. Patients who were less than age 55, who were taken to a non-trauma hospital or who were later transferred to a Level I or Level II trauma center were excluded from the analysis. Missing data was < 10% for all variables and was addressed using multiple imputation methods. We constructed three logistic regression models (all patients age ≥ 55 years, only patients age 55-69 years, and only patients age ≥ 70 years) with mortality as the primary outcome. Models were adjusted for mode of transport (air vs. ground), trauma center level (Level I or Level II), age, race, sex, injury severity score, a dichotomized revised trauma score (< 6 vs. ≥ 6), trauma type (blunt, penetrating, thermal, asphyxiation), and co-morbidities (cardiac, diabetic, neurologic, blood-related, and other).

Data was described using 95% confidence intervals and were statistically compared using logistic regression methods. Adjusted odds ratios and associated confidence intervals for mortality were determined for each regression analysis by comparing patients in each of the three cohorts between air and ground transports. Statistical significance was considered at the $p < 0.05$ level.

This study was approved by the Ohio State University Institutional Review Board and was supported by a grant received from the Department of Public Safety (GRT00027833**).**

Results: Demographic information is provided in Table 1. There were 8,421 patients ≥ 55 years of age in the dataset. There were 7,739 (90.9%) were transported by ground and 682 (9.1%) transported by air. There were 3556 between the ages of 55 to 69 years and an additional 4865 over the age of 69 years.

Of the 3,556 patients who were 55-69 years of age, 3,084 (86.7%) were transported by ground and 472 (13.3%) by air. Of the 4,865 patients who were ≥ 70 years of age, 4,655 (95.7) were transported by ground and 210 (4.3%) by air. The overall mortality among patients in the dataset was 5.6% (n=470). The crude mortality in the ground transport cohort was 4.0% while the air-transported patients had a crude mortality of 8.5%.

In the multivariable model of all patients ≥ 55, air transport was associated with lower mortality (adjusted odds ratio [aOR]=0.60; 95% confidence interval [CI] = 0.39-0.91; p= 0.017) when compared to those transported by ground (Table 2). With the model restricted to patients ages 55-69, air transport was associated with lower mortality (aOR=0.51; 95% CI =0.28-0.93; p= 0.029) than ground (Table 2). It was noted, however, that for patients 70 years or older, air transport was not associated with lower mortality (aOR=0.79; 95% CI =0.427-1.46; p= 0.429).

Also of note in our analysis was the fact that males had a significantly greater risk of mortality compared to females in patients ≥ age 55. (aOR=1.52; 95% CI =1.18-1.95; p=0.001). Patients ≥ age 55 taken to a Level I trauma center did not demonstrate a survival benefit (aOR=1.1; 95% CI = 0.82-1.40; p=0.631) Other factors associated with a greater risk of mortality included a higher ISS and Revised Trauma Score, penetrating or thermal injury and those patients with underlying cardiac disease (Table 2).

Discussion:

Our study was conducted to determine if air medical transport provided a survival benefit in patients age 55 years or older that was examined in a prior study. Those authors showed no survival benefit using multiple logistic regression methods when evaluating data from the National Sample Project.[8] We failed to confirm these findings.

Our study was able to demonstrate a survival benefit for the cohort of patients age greater than 55 years. Further analysis of the specific cohort of patients age 70 years or greater, however, did not show a statistical benefit to air transport. It should be noted that our analysis of the state of Ohio Trauma Registry showed that there is a steep rise in mortality after age 72. As a result, 70 years has been adopted as the state definition for geriatric trauma[9] and geriatric specific-trauma triage criteria exists in Ohio.[10]

There are differences between the two studies that may account for the disparate findings between our two studies. In the case of the National Sample Project, this data is drawn from the National Trauma Data Bank that is a convenience sample of data voluntarily provided by 100 Level I and Level II trauma centers throughout the United States. It is limited by the fact that it does not reflect the true population distribution and by quality of the data submitted by each institution. Air transport may have been used for direct scene as well as inter-hospital transport. In our study, we used an inclusive database maintained by the Central Ohio Trauma System that reflects the population distribution in Ohio. We also limited our analysis to patients who were directly transferred from the accident scene to a major trauma center.

Selecting the appropriate mode of transport is an important component of trauma triage. A recent analysis has shown that the annual US spending on air medical transport is $2.28 billion dollars.[11] More than 500,000 patients are transported by air each year. Additionally, the safety of air transport must also be considered in the risk/benefit analysis of trauma care. While it is clear that geriatric patients are undertriaged[12,13] and benefit from care in a trauma center[14], the mode of transport may not provide the same impact on outcome in the geriatric trauma victim as previously assumed. This study and the study by Sullivent[8] suggest that we must challenge our assumptions regarding the use of air medical services in elderly trauma victims.

Limitations:

There are several limitations to the current investigation. This study suffers from the inherent limitations of a retrospective study which cannot demonstrate cause and effect between mode of transport and mortality benefit in older patients. Clearly, a prospective analysis would be required although a truly randomized design is not feasible. Additionally, our analysis is based on a dataset that clearly shows a difference in patient outcomes beginning at age 70.[9] Our findings must be validated against another database. Finally, there were issues with the data as well. There was a high predominance of patients transported by ground as opposed to air. This likely represents the high concentration of patients in the Columbus area of the Central Ohio

Trauma System and the lower concentration of patients transported by air from more rural environments. Additionally, there were some missing data elements (less than 10% for all fields) that were corrected using statistical imputation methods.

Conclusion: Adult trauma patients aged ≥ 55 years transported by air had a significant (39%) reduction in odds of mortality compared to patients transported by ground. This finding was confirmed for the cohort of patients age 55-69 years. There was no mortality benefit of air transport in patients ≥ 70 years of age. These results indicate air medical EMS transport of adult trauma patients aged 55-69 should continue to be prioritized over ground transport. Further study should evaluate the impact of air transport on mortality in patients.

REFERENCES

1 Baxt, WG, Moody, P: The impact of rotorcraft aeromedical emergency care services on trauma mortality. ***JAMA*** 1983; 249:3047-51.
2 Thomas SH, Harrison TH, Buras WR et al: Helicopter transport and blunt trauma mortality: a multicenter trial. ***J Trauma*** 2002; 52(1):136-45
3 Frankema SPG, Ringburg AN, Steyerberg EW, Edwards MJR, Schipper IB, van Vugt AB: Beneficial effect of helicopter emergency medical services on survival of severely injured patients. ***Br J Surg*** 2004;91:1520–6.
4 Galvagno SM, Haut ER, Zafar SN, Millin MG, Efron DE, Koenig GJ, Baker SP, Bowman SM, Pronovost PJ, Haider AH: Association between helicopter vs ground emergency medical services and survival for adults with major trauma. ***JAMA*** 2012; 307(15):1602-1610.
5 Bledsoe BE, Wesley AK, Eckstein M, Dunn TM, O'Keefe MF: Helicopter scene transport of trauma patients with nonlife-threatening injuries: a meta-analysis. ***J Trauma Inj Inf Crit Care*** 2006; 60:1257-1266.
6 Gearhart PA, Wuerz R, Localia AR: Cost-effectiveness analysis of helicopter EMS for trauma patients. ***Ann Emerg Med*** 1997; 30(4):500-506.
7 Delgado MK, Staudenmayer KL, Wang NE, Spain DA, Weir S, Owens DK, Goldhaber-Fiebert JD: Cost-effectiveness of helicopter versus ground emergency medical services for trauma scene transport in the United States. ***Ann Emerg Med*** 2013; 62(4):351-364.
8 Sullivent EE, Faul M, Wald MM: Reduced mortality in injured adults transported by helicopter emergency medical services. ***Prehosp Emerg Care*** 2011; 15(3):195-202.
9 Caterino JM, Valasek T, Werman HA: Identification of an age cutoff for increased mortality in patients with elderly trauma. ***Am J Emerg Med*** 2010; 28(2):151-158.
10 Werman HA, Erskine T, Caterino J, Riebe JF, Valasek T; Members of the Trauma Committee of the State of Ohio EMS Board: Development of statewide geriatric patients trauma triage criteria. ***Prehosp Disast Med*** 2011; 26(3):170-179.
11 Association of Air Medical Services: Economic analysis of the US rotary winged aircraft industry. 2014, pg 1-55. Available at: http://medevacfoundation.org/wp-content/uploads/2014/08/Rotary-Wing-AMT-Economic-Benefit-Study-EPS-082114.pdf
12 Phillips S, Rond PC 3rd, Kelly SM, Swartz PD. The failure of triage criteria to identify geriatric patients with trauma: results from the Florida Trauma Triage Study. ***J Trauma*** 1996; 40(2):278-83.
13 Nakamura Y, Daya M, Bulger EM, Schreiber M, Mackersie R, Hsia RY, Mann NC, Holmes JF, Staudenmayer K, Sturges Z, Liao M, Haukoos J, Kuppermann N, Barton ED, Newgard CD; WESTRN Investigators: Evaluating age in the field triage of injured persons. ***Ann Emerg Med*** 2012; 60(3):335-45.
14 Meldon SW, Reilly M, Drew BL, Mancuso C, Fallon W Jr: Trauma in the very elderly: a community-based study of outcomes at trauma and nontrauma centers. ***J Trauma*** 2002; 52(1):79-84.

TABLE 1. Demographic data for all patients age ≥ 55 years

Characteristic	Mode of Ambulance Transport Ground n (%)	 Air n (%)	 Total N
Gender			
All	7,739 (91.9)	682 (08.1)	8,421
Male	3,282 (87.5)	465 (12.4)	3,747
Female	4,457 (95.3)	217 (04.6)	4,674
ISS			
<15	6,595 (94.1)	409 (05.8)	7,004
15 - 24	691 (82.4)	147 (17.5)	838
≥25	453 (78.2)	126 (21.7)	579
RTS			
<6	298 (71.6)	118 (28.3)	416
≥6	7,441 (92.9)	564 (07.0)	8,005
Trauma Type			
Blunt	7,508 (92.1)	638 (07.3)	8,146
Penetrating	143 (85.6)	24 (14.3)	167
Thermal	72 (80.0)	18 (20.0)	90
Asphyxiation	16 (88.8)	2 (11.1)	18
Trauma Center			
Level I	2,621 (79.9)	656 (20.0)	3,277
Not Level I	5,118 (99.4)	26 (00.5)	5,144
Transport			
Mode	7,739 (91.9)	682 (8.1)	8,421

TABLE 2. Data Analysis of Patients > 55 Years

Characterisitic	Age ≥55 years AOR	95% CI		p-Value	Age 55 - 69 years AOR	95% CI		p-Value	Age ≥70 years AOR	95% CI		p-Value
Demographics												
Male	1.52	1.18	1.95	0.001	1.48	0.91	2.41	0.111	1.56	1.16	2.09	0.003
Female	Ref.				Ref.				Ref.			
Age	1.06	1.04	1.07	<0.001	1.01	0.96	1.06	0.805	1.04	1.02	1.07	0.001
Trauma center												
Level I	1.068	0.82	1.40	0.631	0.97	0.59	1.60	0.920	1.068	0.77	1.48	0.691
Not Level I	Ref.				Ref.				Ref.			
ISS‡												
ln_ISS	0.39	0.26	0.59	<0.001	0.34	0.17	0.67	0.002	0.42	0.24	0.72	0.001
(ln_ISS)^2	1.67	1.51	1.85	<0.001	1.67	1.41	1.98	<0.001	1.67	1.46	1.92	<0.001
RTS												
≥6	0.05	0.03	0.06	<0.001	0.04	0.03	0.07	<0.001	0.04	0.03	0.07	<0.001
<6	Ref.				Ref.				Ref.			
Trauma Type												
Penetrating	3.01	1.67	5.41	<0.001	2.83	1.36	5.91	0.005	3.20	1.16	8.82	0.024
Thermal	5.02	2.22	11.37	<0.001	4.59	1.60	13.15	0.005	5.22	1.26	21.61	0.023
Asphyxiation	0.56	0.05	6.06	0.635	***	***	***	***	1.56	0.05	46.45	0.796
Blunt	Ref.				Ref.				Ref.			
Comorbidities†												
Cardiac	1.66	1.28	2.15	<0.001	1.36	0.77	2.39	0.285	1.77	1.31	2.39	<0.001
Diabetic	0.95	0.71	1.29	0.756	1.47	0.84	2.55	0.175	0.79	0.55	1.15	0.219
Blood	1.07	0.81	1.41	0.629	1.20	0.64	2.22	0.574	1.04	0.76	1.42	0.806
Neurologic	1.00	0.74	1.35	0.984	1.01	0.48	2.11	0.985	1.00	0.72	1.39	0.982
Other	1.03	0.81	1.33	0.787	1.27	0.81	1.98	0.293	0.94	0.69	1.27	0.668
Transport												
Air	**0.60**	**0.39**	**0.91**	**0.017**	**0.51**	**0.28**	**0.93**	**0.029**	0.79	0.43	1.427	0.429
Ground	Ref.				Ref.				Ref.			

‡ second best m=2 model fractional polynomial powers;
‡ Δdeviance (from best m=2 model, power 1= 0.0; power 2= -0.5) = 27
† no comorbidities is reference
*** omitted (perfectly predicted)