An Analysis of Effect of Transport Mode for Trauma Patients

Original Article

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An Analysis of Effect of Transport Mode for Trauma Patients "Are We Flying the Right Patients?"

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Conflicts of interest: None declared

Abstract

Background: We sought to examine the effectiveness of Helicopter-based Emergency Medical Services (HEMS) in our trauma center. **Methods**: In this single center retrospective study we applied accepted HEMS criteria to 10 years of our registry and then examined patients by whether they met criteria and whether they were transported by HEMS or Ground-based EMS (GEMS) direct from the scene. We compared GEMS and HEMS groups using the Relative Mortality Metric (RMM)[1], W-scores, TRISS scores[2], and measures of hospital care received. **Results:** We found that patients who met any HEMS criteria (MC) had higher injury severity scores (ISS) and were more likely to require immediate critical intervention. MC patients also had improved survival based on comparison to predicted outcomes using W-scores and the RMM validating the use of HEMS in these patients. A similar benefit was not demonstrated for the group that did not meet criteria but who were flown. These patients had lower ISS and were far less likely to require critical care or emergent intervention. Patients who did not meet HEMS criteria comprised 67% of HEMS transports. **Conclusion**: Patients who met accepted HEMS criteria benefitted from air transport as evidenced by improved actual survival compared to expected survival using accepted benchmarks. However, we found that HEMS was over utilized in minimally injured patients. In our region, HEMS is often used for mechanism and the "possibility" of serious injury and our findings could not support this practice. The criteria examined are all easily obtainable in the field and in referring hospitals and could be used to better determine who should be flown.

Level of Evidence: III, Prognostic study, Key Words: Trauma, Mortality, HEMS, Emergency Medical Services, Aeromedical

Background

There has been a longstanding debate over effectiveness of Helicopter-Based Emergency Medical Services (HEMS) transport for trauma patients and what patients benefit most from the resource[3-8]. There is little definitive evidence, mostly due to variation between studies, triage criteria, endpoints, and data from multiple centers with varying degrees of performance. Field triage criteria for trauma, which can be effective for identifying patients requiring trauma center care, do not always appropriately identify those who would benefit from HEMS. Different regions may employ different flight criteria, or none at all making it difficult to standardize criteria for HEMS[3].

Aeromedical transport can bring greater skill, training, and experience to the care of a polytrauma patient in the field but comes with increased risk associated with the transport mode. Crash rates vary between 0.4 and 3.05 per 10,000 missions, which is far greater than commercial flight[7]. The risk profile for aeromedical missions is likely greater due to unpredictable/poor weather, unknown or unprepared landing sites, and stress amongst other factors. Cost of aeromedical resources is another important factor as it can create an undue burden for patients and the systems that bear the cost of unnecessary utilization. For these reasons we would like to better understand what factors would be most likely to indicate which patients would benefit from HEMS enough to offset the risk and financial burden of transportation.

We undertook a study comparing various triage criteria for aeromedical activation and applied them to patients treated at a single trauma center over 10 years. To be transparent, in our region, HEMS transport is left to the discretion of the on-scene medic and EM physician at the referring hospital. To improve our system's performance, we hoped to identify optimal triage criteria that save lives, but do not unduly stress the transport system or create additional risk for flight crews or the patients being transported. We hypothesized that there was underutilization of HEMS in patients who required immediate critical care or operative intervention and that ground EMS transport (GEMS) would be suboptimal for these patients, leading to worse outcomes for GEMS in comparison to HEMS in patients meeting accepted HEMS triage criteria. Examining presenting physiologic factors as well as outcomes after admission should provide some insight into who would benefit most from Aeromedical transport.

Methods

We used the trauma registry from a single level 1 trauma center located in a rural area of Virginia. This registry was under the direction of a single trauma registrar and medical director for the entire length of the study period. The hospital is a state and ACS verified

Level I Trauma Center. There are no other Level I, II, or III trauma centers within 30,000 square ground miles of this center (nearest centers are 99, 72, 120, and 67 miles distant by ground respectively) or within 22,000 square air miles, so transfer of patients to another trauma center was not investigated in this study.

Triage Criteria

We queried the literature for HEMS triage criteria and identified the following as being commonly employed. First, the CDC National Field Triage guidelines[9] have been cited by many previous studies. It is a multiple tiered algorithm, and the American College of Surgeons has previously endorsed the first two steps as being reasonable for HEMS transports to Trauma centers[10], especially if distance is a factor. Major physiologic criteria that are employed include Glasgow Coma Scale (GCS) ≤13, Systolic BP <90 mmHg, and respiratory rate <10 or >29 breaths per minute. The National Association of EMS physicians uses physiologic criteria along similar lines as well as a lower GCS score of <10 in previous guidelines[3]. Presenting values in our Emergency Department were available in our registry and were used.

Data Analysis

After removing records where there was insufficient data to apply triage criteria, we applied these criteria to patients admitted to the trauma center. In addition, we removed records from Charlottesville City and Albemarle county as they are near (generally <15 miles) to UVA and have rare circumstances where HEMS can be employed. Patients discharged from the ED were not included since they are not abstracted by the registry. However, historically, less than 1% of patients seen by the trauma service are discharged to home without at least overnight observation. After subdividing the groups by whether they met the individual triage criteria, we further subdivided them by mode of transport. We also created groups that met any of the triage criteria and compared patients transported by air and ground that did or did not meet any of the criteria. Injury and procedure data within the registry were used to assess patient injury and the need for immediate definitive care. These included Hospital days, Emergency department disposition, Ventilator days (if applicable), percentage of survival, expected survivors, mortality, ISS, RMM, and W-score.

Statistical Significance T-tests or ANOVA were used to compare parametric variables between groups. Categorical variables were compared using the Chi squared and Fisher's Exact tests. The relative mortality metric (RMM), developed by UVA[1,11-13] was used to compare outcomes along the spectrum of predicted survival for patients who met transport criteria and those who did not, and between the total number of patients transported by air or ground. In brief, the RMM is a statistical tool that compares actual to expected outcome in discrete Probability of Survival bands and combines performance in these bands into a single number that can be used to compare performance. It also includes the graph known as the Relative Mortality Performance Trend (RMPT) which can be used to assess significant differences in performance. For the RMPT bars, that do not cross the isomortal line (where actual mortality equals expected mortality) are considered to have significantly different outcomes. The *W score* is calculated as (actual survivors-predicted survivors/number of patients/100). A positive *W* score indicated excess survivors per 100 trauma patients. For other tests, $P < .05$ was considered significant[14,15]. To additionally assess outcome differences, we statistically compared predicted vs. actual mortality for the groups.

Results

This study included 8315 patients from 2006-2017 within our trauma registry. We found that there was a statistically significant difference in hospital days (10.28 for HEMS and 5.73 for GEMS, $p < .001$) regardless of triage criteria. Mean ISS was also higher at 14.75 for HEMS compared to 8.84 for GEMS ($p < .001$). We also found that 60% and 86% of HEMS and GEMS respectively had an ISS <15. HEMS also had a lower mean GCS and higher percentage of GCS <10 and ≤13 (Table 1). Overall there was a significant difference between actual and predicted mortality rates in both the GEMS and HEMS.

GCS <10 group At our center we found that there were 831 patients with GCS <10 (Table 2). Most of these patients in both the Air and ground groups went directly to the OR or ICU from the ED (Table 2). A high percentage had recorded ventilation time in both groups. W-scores showed excess survivors at 25.76 compared to 6.68 for HEMS compared to GEMS. Mean ISS and proportion of entries with ISS <15 were similar in both groups. Importantly, there was a significant difference between actual and predicted mortality in the HEMS group, but not in the GEMS group.

GCS ≤13 group There were 1081 patients in this group (657 Air /299 ground) (Table 2). Hospital days were significantly higher in the Air group at 15.70 compared to 12.57 (p< .0273). There was no clear gross mortality benefit between the two groups, although W-scores showed excess survivors in the Air group at 23.85 compared to 5.48 for ground. HEMS also had fewer minimally injured patients (ISS<15) at 33% compared to 43% for

GEMS (p=0.0033). Again, using these criteria there was a significant difference between actual and predicted survival in the HEMS group but not in the GEMS group.

Systolic Blood Pressure <90 mmHg There were 294 patients in this group (Table 3). Air had significantly increased hospital days at 14.95 compared to 7.89 for ground (P=0.0273). W-scores were higher for Air at 17.47 compared to 1.41. ISS was also much higher in the air group at 24.90 compared to 17.51 (p< .05). Those in the HEMS group had a much smaller percentage with ISS<15 (22% HEMS compared to 50% GEMS). In the GEMS group the actual survival was similar to predicted, but in the HEMS group actual survival was significantly better in the HEMS group (*p* =0.47 in GEMS vs 0.004 in HEMS).

Respiratory rate <10, >29, intubated, or ventilated There were 1125 total patients in this group with a predominance towards air (Table 3). Mean hospital days were increased with Air patients at 15.08 compared to 9.79 (p< .001). W scores were again much higher in Air at 21.62 compared to 3.63. Mean ISS was much higher in air at 20.60 compared to 15.68 in ground (p< .001). Again, a smaller percentage of HEMS (39%) had ISS<15 compared to GEMS (57%). Once again, actual survival was significantly better than predicted in the HEMS group but not in the GEMS group.

Any criteria met 1357 patients met any of the above criteria (MC). Mean hospital days were greater in HEMS at 15.48 to 9.98 (p< .005) (Table 4). More HEMS patients went to OR or ICU compared to GEMS. A large percentage of GEMS patients went to the floor, 29% GEMS compared to 9% HEMS. W-scores were again increased in HEMS at 20.11

compared to 3.21 in GEMS. ISS scores with higher in the HEMS group at 20.47 compared to 15.41 ground ($p < .001$). There were fewer ISS<15 records in the HEMS group (38%) compared to the GEMS group (57%). Actual mortality was significant less than predicted in the HEMS group but not in the GEMS group. This was confirmed with the RMM showing that the HEMS group showed a statistically significant improvement in survival across all POS bands at 0.4804 HEMS (95% CI, 0.3585-0.6023) compared to 0.1497 GEMS (95% CI, -0.0532-0.3525) for relative survival (Figure 1).

No criteria met: There were 6997 patients in the group that did not meet (DMC) any of the triage criteria with 1698 being transported by air (Table 4). DMC group HEMS was over twice that in MC group HEMS. Mean hospital days were increased compared to GEMS in DMC group at 7.85 compared to 5.32 for ground ($p < .001$). There was a notable difference in HEMS hospital days in MC group and HEMS DMC group at 15.48 to 7.85. 43% of those transported by HEMS in DMC group did not require ICU or intermediate this was a highest-level activation care compared to 9% in those transported by HEMS in MC group.

HEMS had 19% in DMC compared to 22% in MC who went to the OR from the ED. 37% of HEMS compared to 20% of GEMS in DMC went to the ICU from ED compared to 65% HEMS and 48% GEMS in the MC group.

9% HEMS and 7% GEMS in DMC group required mechanical ventilation compared to 37% HEMS and 28% GEMS in MC group and days on ventilator were decreased at 4.96 days HEMS and 2.10 days GEMS in DMC compared to 7.61 days HEMS and 6.52

GEMS in MC group. The mean calculated percentage of survival (POS) was 98% for HEMS and 98% for GEMS ($p < .005$) in the DMC group compared to 59% HEMS and 76% GEMS in MC ($p < .05$). W scores were noted to be lower in HEMS and GEMS of DMC, and these groups had larger RMM values. HEMS RMM was 0.7456 (95% CI, 0.5301-0.9611) and GEMS was 0.5309 (95% CI, 0.3328-0.7290). Mean ISS was lower in DMC at 11.96 for HEMS and 8.23 for GEMS ($p < .001$) compared to 20.47 for HEMS and 15.41 for GEMS in MC ($p < .001$). 71% of HEMS and 88% of GEMS patients in DMC group had an ISS<15. Actual survival was greater than predicted in HEMS and GEMS.

Discussion

Our research question grew from experiences where we perceived a delay in presentation at our trauma center in patients requiring critical interventions. Our trauma center has a catchment area of over 22,000 square air miles with no other trauma center of any level within 50 miles. Thus, with long ground transport times, HEMS transport of critically injured patients was perceived as lifesaving and inappropriate use of ground transport as life endangering for critically injured patients. In addition, different jurisdictions had differing protocols for HEMS, creating more variability.

We clearly demonstrated that for patient meeting any or all currently accepted HEMS transport criteria, survival was significant better than predicted if they were flown, whereas in none of these categories was that true if the patients came by ground. We believe this validates the use of HEMS in patients meeting any or all of these transport criteria confirming one of our original hypotheses. While it was impossible for us to discern retrospectively which patients could not be flown due to weather or the lack of an available helicopter, we confirmed that a sizable percentage of these patients arrived by ground and did not benefit from this outcome advantage (27% of patients with GCS<10, 31% of GCS≤13, 48% of patients with SBP<90, and 34% of patients meeting respiratory criteria). Overall, 40% of patients meeting any criteria were transported by ground. In this group, there were 17 additional unexpected survivors per 100 patients if they were transported by air vs. ground using the *W* score analysis.

While we found significant undertriage detailed above, there was significant overtraige as well. We found that in the region surrounding our trauma center there appeared to be inconsistent use of HEMS triage criteria, and many patients are transported by air that do not meet any criteria and are found to be minimally injured without need for critical care. Triage criteria have been employed and physiologic criteria seem to be superior to mechanism-based criteria based on prior studies[3]. Our findings supported that hypothesis that HEMS was very beneficial for patients meeting physiologic criteria, but also found many HEMS transports did not meet any criteria, did not require critical care, and were likely unnecessary putting patients and crews at risk and incurring significant cost.

We found that patients who met individual criteria tended to be more injured than the total population, and their individual subgroups (HEMS/GEMS) at our center based on ISS, GCS, and ED disposition. Patients in the MC group were on average significantly more injured and there was a survival benefit for those who met these criteria and were transported by HEMS compared to GEMS based on actual survival vs predicted survival utilizing TRISS, W-scores and validated by the RMM. Even though overall mortality was higher in the HEMS group, the expected survivors and W-scores indicate that more of these patients survived than expected. The RMM demonstrated increased relative survival in the DMC criteria if patients were transported using HEMS although W-scores were much more similar. We also noted that many more patients who met no criteria in the HEMS and GEMS groups went directly to the floor from the ED and fewer went to the ICU or Operating Room. A large percentage of these patients were also found to have ISS scores <15 indicating that they had sustained relatively minor injuries. The DMC group also made up a large proportion of the overall HEMS utilization. One metric we used to approximate injury and need for intensive care was need for ventilator and duration of time on ventilator. Both were decreased in both groups of DMC group compared to MC group.

We found that patients who met any of these criteria were on average much more injured and more likely to be on a ventilator, require immediate ICU care, or require immediate OR intervention. Patients in the MC group also had improved survival if transported by HEMS compared to GEMS. This would suggest that patients in the MC GEMS group benefit from HEMS transport, while those in the DMC group would be less likely to see a benefit from HEMS compared to GEMS. This suggests a significant overutilization of HEMS in our region as many minimally injured patients are transported by HEMS.

One major limitation of this study is the relative lack of scene vital signs or physiologic factors in our registry compared to hospital data. Initial ED vitals were used as an approximation. As a result, they may not reflect patient condition upon assessment by EMS where the transport mode decision was made. Critical EMS interventions could improve those factors or the natural course of the injuries of the patient could cause them to have deteriorated more than their initial presentation. This could cause shifts in patients out of different physiologic criteria groups. Another limitation is that DMC group had a highly skewed POS distribution and a very large mean POS making application of the RMM difficult. Weather can also influence whether flight is an option. Some patients who transported by ground might have been identified as candidates for air transport but could not be transported due to weather. Another interesting factor is how many patients could not be transported that met criteria because a helicopter was being used to transport a patient that would not gain value from air transport. This could not be examined retrospectively but is part of an ongoing prospective analysis. We also did not examine inter-hospital vs. scene transfer though we have previously [(8).] This will be our next study.

Based on our results, efforts should be undertaken to ensure that any patient in the field who meets any of the criteria cited have rapid access to helicopter transport to trauma centers within weather and resource constraints. Conversely, it would seem reasonable to refine current systems to ensure that patients who do meet established HEMS criteria be transported by ground in most circumstances. There may be exceptional situations that fall outside of the established criteria, but more accurate application of HEMS criteria would likely make better use of this highly valuable resource.

Author Contribution:

Andrew M Young: Literature review, data interpretation, writing, revision

Philip H Schroeder: Data analysis, data interpretation, revision

Christopher L Cramer: Data gathering, revision

Jeffrey S Young, MD, MBA: Data interpretation, writing, critical revision

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Table 1: Overall registry analysis

	All EMS				
	Total	**GEMS**	**HEMS**	**p value**	
Gross n	8315	5870	2439		**Gross (all entries)**
Mean Hospital Days	7.06±11.29	5.73±9.070	10.28±14.92	< .001	
ED Disposition to Operating Room	15.09%	13.17%	19.72%	< .001	
ED Disposition to ICU	29.12%	22.01%	46.21%	< .001	
ED Disposition as Expired	0.7336%	0.5451%	1.189%	0.001743	
Proportion with Recorded Ventilator Time	11.28%	8.38%	18.29%	< .001	
Mean GCS	13.70±3.448	14.45±2.152	11.92±4.974	< .0001	
ISS< 15	78.03%	85.52%	60.15%	< .0001	
Mean ISS	10.59±8.621	8.84±6.893	14.75±10.67	< .0001	
Gross Mortality	4.34%	2.86%	7.91%	< .001	
Risk adjusted n (entries with POS)	7140	4922	2213		**Risk Adjusted**
Mean POS	0.9277±0.1890	0.9627±0.1290	0.8498± 0.2636	< .001	
Anticipated survivors (rate)[b]	6624 (92.77%)	4738 (96.27%)	1881 (84.98%)		
Actual survivors (rate)	6831 (95.67%)	4780 (97.11%)	2046 (92.45%)		
p-value (ant/actual)	< .0001	.01800	<.0001		
W-score	2.90	0.84	7.47		

[a]Percentage of survival. [b]Sum of percentage of survival for each patient in group. GEMS: Ground-based Emergency Medical Services, HEMS: Helicopter-based Emergency Medical Services

Table 2: GCS Criteria Analysis

	GCS<10				**GCS≤13**				
	Total	**GEMS**	**HEMS**	**p value**	**Total**	**GEMS**	**HEMS**	**p value**	
Gross n	831	232	599		956	299	657		**Gross (All entries)**
Mean Hospital Days	15.45±22.30	13.69±21.28	16.14±22.67	.1440	14.72±21.23	12.57±19.58	15.70±21.88	.0273	
ED Disposition to Operating Room	19.86%	15.09%	21.70%	.031957	19.35%	15.72%	21.00%	.055127	
ED Disposition to ICU	68.11%	65.09%	69.28%	.244313	66.32%	60.20%	69.10%	.006939	
ED Disposition as Expired	6.98%	12.93%	4.67%	< .001	6.17%	10.03%	4.41%	< .001	
Proportion with Recorded Ventilator Time	41.88%	44.40%	40.90%	.359609	40.80%	41.81%	40.33%	.667844	
Mean GCS	3.774±1.697	4.522±2.160	3.484±1.376	< .005	4.728±2.940	6.010±3.384	4.145±2.508	< .001	
ISS< 15	31.64%	33.48%	30.94%	.482918	36.35%	43.20%	33.28%	.003323	
Mean ISS	22.09±12.46	21.20±12.37	22.43±12.48	.0162	20.95±12.57	18.90±12.24	21.87±12.61	.0004	
Gross Mortality	30.93%	40.09%	27.38%	< .001	27.62%	32.11%	25.57%	.0521	
Risk adjusted n (entries with POS)	733	197	536		841	253	588		**Risk Adjusted**
Mean POS	0.4840±0.3038	0.5220±0.3346	0.4700±0.2907	.0906	0.5397±0.3227	0.6171±0.3461	0.5064±0.3064	.0906	
Anticipated Survivors (rate)	354 (48.40%)	102 (52.20%)	252 (47.00%)		453 (53.97%)	156 (61.71%)	297 (50.64%)		
Actual Survivors (rate)	506 (69.03%)	116 (58.88%)	390 (72.76%)		608 (72.29%)	170 (67.19%)	438 (74.49%)		
p-values (ant/actual)	< .0001	.1875	< .001		< .0001	.1936	< .001		
W-score	20.63	6.68	25.76		18.32	5.48	23.85		

[a]Percentage of survival. [b]Sum of percentage of survival for each patient in group. GEMS: Ground-based Emergency Medical Services, HEMS: Helicopter-based Emergency Medical Services

Table 3: Vital signs Criteria Analysis

	SBP<90 mmHg				**RR <10, >39, intubated or ventilated**				
	Total	**GEMS**	**HEMS**	**p value**	**Total**	**GEMS**	**HEMS**	**p value**	
Gross n	294	142	152		1125	387	737		**Gross (All entries)**
Mean Hospital Days	15.45±22.30	13.69±21.28	16.14±22.67	.1440	14.72±21.23	12.57±19.58	15.70±21.88	.0273	
ED Disposition to Operating Room	11.54±16.43	7.89±8.804	14.95±20.67	< .005	13.25±20.09	9.79±16.41	15.08±21.57	< .005	
ED Disposition to ICU	26.53%	18.31%	34.21%	.002029	18.67%	14.73%	20.76%	.013707	
ED Disposition as Expired	45.58%	41.55%	49.34%	.1800	59.56%	47.29%	66.08%	< .001	
Proportion with Recorded Ventilator Time	14.97%	18.31%	11.84%	.1203	4.98%	7.24%	3.80%	.01188	
Mean GCS	9.297±5.794	10.90±5.509	7.847±5.680	.8253	7.080±5.307	9.952±5.587	5.583±4.481	.0328	
ISS< 15	35.29%	50.37%	21.71%	< .001	45.04%	56.92%	38.78%	< .0001	
Mean ISS	21.40±13.56	17.51±13.09	24.90±13.05	< .005	18.90±12.54	15.67±12.14	20.60±12.41	< .005	
Gross Mortality	33.33%	31.69%	34.87%	.5635	22.04%	21.71%	22.25%	.9947	
Risk adjusted n (entries with POS)	254	117	137		962	309	652		**Risk Adjusted**
Mean POS	0.5568±0.4113	0.6611±0.4007	0.4676±0.4005	.0604	0.6132±0.3431	0.7178±0.3500	0.5630±0.3284	< .001	
Anticipated Survivors (rate)	141 (55.68%)	77 (66.11%)	64 (46.76%)		589 (61.32%)	221 (71.78%)	367 (56.30%)		
Actual Survivors (rate)	167 (65.75%)	79 (67.52%)	88 (64.23%)		742 (77.13%)	233 (75.40%)	508 (77.91%))		
p-values (ant/actual)	.01822	.4655	.003530		< .0001	.3153	< .001		
W-score	10.07	1.41	17.47		15.82	3.63	21.62		

[a]Percentage of survival. [b]Sum of percentage of survival for each patient in group. GEMS: Ground-based Emergency Medical Services, HEMS: Helicopter-based Emergency Medical Services

Table 4: Triage Criteria Analysis

	Meets any Criteria[a] (MC)				**Doesn't meet criteria (DMC)**				
	Total	**GEMS**	**HEMS**	**p value**	**Total**	**GEMS**	**HEMS**	**p value**	
Gross n	1357	539	817		6997	5293	1698		**Gross (All entries)**
Mean Hospital Days	13.29±19.64	9.981±15.18	15.48±21.84	< .001	5.933±8.452	5.321±8.074	7.845±9.293	< .001	
ED Disposition to Operating Room	19.60%	16.33%	21.79%	0.01321	14.08%	12.64%	18.55%	< .001	
ED Disposition to ICU	58.59%	48.42%	65.36%	< .001	24.10%	19.88%	37.22%	< .001	
ED Disposition as Expired	4.348%	5.566%	3.550%	0.07489	0.014%	0.019%	0.000%	0.3964	
Proportion with Recorded Ventilator Time	33.60%	27.83%	37.45%	< .001	7.175%	6.537%	9.187%	< .001	
Mean GCS	7.768±5.408	10.19±5.316	6.189±4.857	0.0789	14.85±0.5555	14.87±0.5290	14.80±0.6287	< .001	
ISS< 15	45.59%	56.66%	38.28%	< .001	84.12%	88.28%	71.21%	< .001	
Mean ISS	18.46±12.26	15.41±11.64	20.47±12.25	< .001	9.138±6.825	8.228±5.888	11.96±8.541	< .001	
Gross Mortality	20.27%	19.11%	21.05%	< .001	1.172%	1.171%	1.178%	0.9996	
Risk adjusted n (entries with POS)	1158	431	726		6246	4644	1597		**Risk Adjusted**
Mean POS	0.6539±0.3342	0.7591±0.3180	0.5909±0.3280	< .001	0.9802±0.0610	0.9820±0.0639	0.9752±0.0515	< .005	
Anticipated Survivors (rate)	757 (65.39%)	327 (75.91%)	429 (59.09%)		6,123 (98.02%)	4,561 (98.20%)	1,557 (97.50%)		
Actual Survivors (rate)	917 (79.19%)	341 (79.12%)	575 (79.20%)		6,173 (98.79%)	4,588 (98.79%)	1,580 (98.94%)		
p-values (ant/actual)	< .0001	.2535	< .001		< .001	.0209	< .002994		
W-score	13.80	3.209	20.11		0.8069	0.5907	1.433		
RMM[e]	**0.3742**	**0.1238**	**0.4873**		**0.5471**	**0.5309**	**0.7456**		
RMM Lower Limit (95% CI)	**0.3008**	**-0.0605**	**0.3412**		**0.3541**	**0.3328**	**0.5301**		
RMM Upper Limit (95% CI)	**0.4476**	**0.3081**	**0.6334**		**0.7401**	**0.729**	**0.9611**		

[a]Includes GCS≤13, Systolic Blood pressure <90mmHg at first record, Respiratory rate <10, >29, intubated or bagged [b]Percentage of survival, [c]Sum of percentage of survival for each patient in group. [d]Total alive with POS recorded, [e]Relative mortality metric[1] GEMS: Ground-based Emergency Medical Services, HEMS: Helicopter-based Emergency Medical Services

Figure 1: RMPT of GEMS vs. HEMS (MC group)