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RESEARCH REPORTS

HELICOPTER EMERGENCY MEDICAL SERVICES (HEMS) TRANSPORTATION UTILIZATION FOR ACUTE ISCHEMIC STROKES AT A COMPREHENSIVE STROKE CENTER IN SOUTH FLORIDA

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ABSTRACT

Background: A comprehensive stroke center (CSC) servicing remote areas in South Florida became HEMS direct-from-field capable on October 15, 2020. This analysis reviews the utilization of this service and compares it to ground EMS (GEMS).

Methods: This is a retrospective cohort study from October 15, 2020, to July 31, 2021, that collected HEMS adult stroke alert data and compared it to the prior year's summary GEMS stroke alert data. Using HEMS transportation logs, presenting stroke symptoms and prehospital assessment were abstracted, in addition to initial NIHSS, downgrade rate, stroke diagnosis percentage, treatment rate, and times.

Results: The analysis included a total of 52 direct transport HEMS stroke alerts. Assessment tools utilized by HEMS included the Cincinnati stroke scale (4%) and the FAST-ED (37%); most cases (59%) did not document a stroke assessment tool. The median NIHSS was 10, with 37% presenting a score <6. Cases were downgraded upon arrival in 27% and after CT imaging in 15% of cases. Significantly (p<.001), more HEMS cases were diagnosed as stroke (69%) compared to GEMS (57%). Stroke treatment rates remained similar (HEMS=23%; GEMS=24%). Median door-to-needle times were significantly faster for HEMS (15 min) than GEMS (25 min) (p<.05). Median door-to-puncture times were clinically faster for HEMS (61mins) than GEMS (66 mins).

Conclusion: Prehospital triage could be improved to better detect the 77% of patients who are not eligible for acute stroke reperfusion treatments and may benefit from ground as opposed to from the field air transportation. The current HEMS triage, although not consistently documented, appropriately selects stroke victims, but not necessarily those who need air transport to a higher care level. Patients arriving via HEMS receive similar access to stroke treatment and, if treated, significantly faster treatment times.

INTRODUCTION

In prior studies, the use of HEMS (Helicopter Emergency Medical Services) has been shown to improve patient outcomes. Still, there is concern about the overuse of HEMS in minimally injured and/or acutely affected patients (Vercruysse et al., 2015). Professional associations have published guidelines to aid in the health care provider's decision on whether to use helicopter transport (Lenz et al., 2018). However, whether these guidelines are implemented correctly and accordingly could explain the discrepancy in patients who are inappropriately transferred to high-acuity hospitals. A retrospective study reviewed patients who were airlifted and cross-referenced the guidelines used by air transport with the recently published guidelines to determine if the correct criteria were met before airlifting each patient (Lenz et al., 2018). Results found that compliance with recommended policies varied from 50 to 85%, depending on which criteria were utilized (Lenz et al., 2018).

Over-triage of patients who are ineligible for acute stroke reperfusion therapies by HEMS places patients and clinicians at unnecessary risk (i.e., flight hazards, weather conditions, mechanical malfunction) and contributes to the waste of health care resources. The benefits of this transport modality must be weighed against the risks to patients and health care providers as well as the costs to the health care system and communities (Adcock et al., 2020). These studies highlight the need for additional research to find the appropriate balance between cost-effectiveness and appropriate stroke triage. This is especially important where resources are limited and may interfere with availability for other high-severity cases.

Our institution gained HEMS direct-from-field capability on October 15, 2020, prompting the inquisition of appropriate helipad processes and protocols related to acute stroke intervention. Using a retrospective study, we chose to review the differences between the two modes of transportation, ground versus air, with the aim of evaluating the correlation between triage severity (prehospital and hospital stroke assessments) and acute intervention (stroke treatment rate and times). Additionally, we compared the percentage of diagnosed stroke cases between the two categories (HEMS to ground emergency medical services (GEMS) cases). Lastly, for awareness and educational purposes, we tracked the prehospital stroke triage tool being used by our local public rescue organization.

METHODS

This retrospective study evaluated direct-from-field suspected stroke cases that arrived at our institution between October 15, 2020, to July 31, 2021 from a public rescue organization that provides ground and air transportation services to several communities within a set geographical location. Service dispatch, direct-from-field dispatch, and triage decision-making are guided by the rescue organization's protocols that are independent of the hospitals they serve. The HEMS serves rural regions in South Florida that lack certified primary stroke centers even though there are local hospitals with advanced imaging capabilities able to administer thrombolytics to acute ischemic stroke patients. Therefore, there are instances in which time-sensitive transfers by HEMS from these rural areas to a comprehensive stroke center (CSC) are required.

The inclusion criteria consisted of direct-from-field stroke alerts transported by HEMS. Those younger than 18 years and pregnant women were excluded from the study. The data was only collected from direct-to-field HEMS transportation logs (hospital-to-hospital HEMS transfers were excluded).

Variables included presenting stroke signs and symptoms (stroke alert status based on county protocols), the airlift location, the distance to the nearest stroke-certified hospital and community-based hospital facility (stroke-certified or not), and initial prehospital clinical and stroke assessment. This information was collected from the prehospital transportation logs. Airlift locations were grouped into general geographic locations for ease of calculating travel distance. Patient charts were reviewed for demographics such as age, sex, and ethnicity. Stroke assessments upon arrival were collected from the emergency department (ED) including the initial National Institute of Health Stroke Scale (NIHSS). Patient stroke priority was recorded upon arrival. Stroke priority 1 is given to those eligible for acute stroke reperfusion therapies such as thrombolytics or endovascular thrombectomy. Stroke priority 2 is given to those with acute stroke but deemed not eligible for such treatments. It was also noted if the patients were downgraded to priority 2 upon arrival or after CT imaging and patient disposition after arrival at the ED. Stroke priority was downgraded upon arrival if an individual was no longer deemed a candidate for acute stroke reperfusion therapies for any reason (i.e., being out of the treatment time window, hemorrhage found by CT, etc.).

Stroke treatment included the use of thrombolytics, mechanical reperfusion (MR), or both. Additional variables investigated include the date and time of the last known well and stroke treatment times. Diagnostic scores were collected including the Hunt and Hess Scale and intracranial hemorrhage (ICH) score in addition to any neurosurgical intervention performed (clipping, coiling, or drain). The final diagnoses were grouped into five categories transient ischemic attack (TIA), acute ischemic stroke (AIS), ICH, subarachnoid hemorrhage (SAH), and non-strokes. Final disposition and NIHSS upon discharge were also recorded. Special attention was given to factors that may help differentiate stroke, stroke mimics, and stroke treatment eligibility, as these factors may help improve EMS education and prevent over-triaging for stroke HEMS. This study was reviewed and approved by the local Institutional Review Board (BHSF1796419) with a full HIPPA waiver and full exemption from consent.

Statistical analysis

All HEMS data were compared to GEMS stroke summary data from 10/01/2020 to 07/31/2021 reported by the hospital (see Table 1). To enable comparisons and improve the study sample size, final diagnoses, and stroke treatment were consolidated into two categories--coded as stroke diagnoses (TIA, AIS, ICH, SAH) or non-stroke diagnoses (stroke mimics) and received stroke treatment (alteplase

Characteristics	HEMS N=52	GEMS N=501	P-Value
Stroke Type % (N)			
AIS	46.2 (24)	42.7 (214)	.36
ICH	15.4 (8)	7.2 (36)	<.05*
SAH	1.9 (1)	3.6 (18)	.39
TIA	5.8 (3)	3.2 (16)	.25
Coded Stroke	69.2 (36)	56.7 (284)	<.05*
Treatment % (N)			
Neurosurgery	1.9 (1)	2.4 (12)	0.25
Thrombolysis	11.5 (6)	17 (85)	<.05
MR	17.3 (9)	12.8 (64)	<.05*
Thrombolysis & MR	5.8 (3)	4.9 (25)	0.77
Stroke treatment	24 (12)	25 (125)	0.75
Metrics			
Door to Needle, M (IQR)	15 (7)	25 (5.75)	<.05*
Door to Puncture, M (IQR)	61 (17.5)	66 (17.5)	0.26

Note: HEMS= helicopter emergency medical support; GEMS= ground emergency medical support; AIS = acute ischemic stroke; ICH = intracranial hemorrhage; SAH = subarachnoid hemorrhage; TIA = transient ischemic attack; MR = mechanical reperfusion, Stroke treatment = all subjects treated with a stroke intervention; M = median; IQR = interquartile range; * = statistical significance.

Table 1. Characteristics for HEMS sample compared to GEMS summary reported data.

or mechanical reperfusion; for this analysis, neurosurgical interventions were not considered stroke treatment) or no stroke treatment. Nonparametric single-sample chi-square tests, using the GEMS data as the hypothesized test value, were used to assess categorical variable significance. Whereas one-sample Wilcoxon Signed Rank tests, using the GEMS data as the hypothesized test value, were used to assess continuous variable significance. Statistical evaluations were performed using SPSS (v27) at the 0.05 significance level. Sample descriptions were provided for the original and consolidated HEMS variables.

RESULTS

Demographics

HEMS transported 52 patients to a community-based CSC hospital in South Florida between October 15, 2020, to July 31, 2021, from five rural areas in South Florida. The cohort comprised 31 (59.6%) males and 21 (40.4%) females. Race and ethnicity percentages were: 63.5% White (n=33), 3.8% Black (n=2), 23.1% White Hispanic (n=12), 1.9% Black Hispanic (n=1), and 7.7% Other (n=4), which are consistent with the rural population and differs from the predominantly Hispanic population within the hospital's major metropolitan area. The average age was 68.13 (SD, range 24-90), and the average length of stay was 11.21 (SD, range 1-87).

All patients were last known to be well within the 24-hour time range required for endovascular treatment. Thirty-nine (75%) subjects were last known to be well within the 4.5-hour time range, whereas 12 (23.1%) fell outside this time window; one (1.9%) subject was missing this information. Most patients were diagnosed with AIS (46.2% n=24), followed by ICH (15.4% n=8), SAH (1.9 % n=1), and TIA (5.8% n=3). The remaining subjects did not receive a primary stroke diagnosis (30.8% n=16). Overall, 69.2% (n=36) received a stroke diagnosis with 21.2% (n=11) considered large vessel occlusions. Of the HEMS arrivals, 13 received acute intervention including neurosurgical coiling (n=1), thrombolysis (n=6), MR (n=9), and thrombolysis and MR (n=3). The remaining cases (75%; n=39) were medically managed and did not receive neurosurgical intervention.

Transport Distance

Subjects arrived from five rural locations with an average distance traveled of 70.2 miles (SD=15; range 16.6-101). Two of the five transportation sites are located more than 100 miles from the closest comprehensive center and accounted for 44% (n= 23) of the sample. Conversely, the closest transportation site (16.5 miles) accounted for 29% (n=15) of the sample. The closest site had the option to select either ground or airlift for transportation. The remaining two sites are respectively 79 miles and 37 miles from the closest comprehensive center and accounted for 27% (n=14) of the sample. When considering the average distance to an advanced imaging capable hospital that can also administer thrombolytics (not a certified stroke center), approximately, 64% (n=33) were within 21 miles, 7% (n=4) were within 11.5 miles, and 29% (n=15) were within 3.5 miles.

Prehospital Assessment Tools

The assessment tools utilized by HEMS included the Cincinnati stroke scale (3.8 % n=2) and the Field Assessment Stroke Triage for Emergency Destination (FAST-ED) (36.5%

n=19). The remaining subjects (59% n=31) lacked prehospital assessment documentation. The median initial NIHSS was 10, with 37% presenting with an NIHSS score <6. Downgrade upon arrival was 27% of cases and downgrade after CT imaging was 15% of cases. Forty-one (78.8%) subjects underwent a full stroke work-up. Significantly, more HEMS cases were diagnosed as a stroke (69%) compared to GEMS (57%) (p<.05, 2=3.57). However, stroke treatment rates remained similar between HEMS (23%) and GEMS (24%). The observed median door-to-needle times were significantly faster for HEMS (15min) than GEMS (25min) (p<.05, W=-2.0). Median door-to-puncture times were clinically faster for HEMS (61mins) compared GEMS (66 mins), but this improvement did not meet statistical significance (p=.26, W=-1.13).

DISCUSSION

This study investigated direct-from-field HEMS usage, stroke treatment rates and times, and explored the assessment tools used by prehospital personnel serving a busy community CSC. Compared to GEMS, we found HEMS stroke transports to be associated with a high discharge diagnosis of stroke, similar treatment rates and faster acute stroke reperfusion therapies, for both thrombolytic and endovascular therapies. Unfortunately, more than   of all transported cases did not qualify for acute stroke reperfusion therapies and could have likely benefitted from ground, rather than air transportation, highlighting an opportunity for triage improvement. Consistently implementing prehospital stroke assessment tools might help decrease the number of emergency air transports that would later be downgraded, thus allowing for an appropriate transfer modality to the correct health care facility. It is unclear if in this setting, additionally performing a prehospital brief telemedicine consultation with the receiving acute stroke treatment team would improve field triage. Of note, there is an opportunity to utilize local community advance imaging capable hospitals if LVO suspicion is low as 36% of transported patients were within 11.5 miles and all patients were within 21 miles from this facility. Brain imaging is critically valuable in the decision-making process on whether a higher level of stroke care is required.

Initial assessments are important for clinical decision-making. However, in our study we found that more than 50% of the patients brought in by HEMS had no documented prehospital assessment, making it difficult to ascertain appropriate triage and transportation selection. Efficiency in the transfer of patients with ischemic stroke amenable to acute reperfusion therapies is a vital factor in the patient's prognosis. EMS personnel should make these decisions using established prehospital assessment tools (Goyal et al., 2016; Regenhardt et al., 2018; Thomalla et al., 2018). Educating personnel on the importance of documenting the use of these prehospital scales will allow accurate compliance determination and process improvement initiatives to be made.

Notwithstanding these challenges, the current study reported that 75% of HEMS subjects arrived within the thrombolysis window, 11.5% underwent thrombolysis and 17.3% underwent MR, remaining consistent with GEMS. This finding aligns with a recent review that found that HEMS was not associated with higher MR treatment rates (Tal et al., 2021). Furthermore, a study by Hawk and colleagues reported that a 3-step EMS triage for AIS allowed for improved thrombolytic treatment times (Hawk et al., 2016). We found that most patients arrived within the thrombolytic treatment window and did have faster DTN and DTP times compared to their GEMS counterparts. Overall, these results indicate our local HEMS triage efforts appear to be effective in detecting AIS victims but are less efficient at determining general eligibility for treatment. This suggests a potential benefit for either clinician input or a clinical decision-making algorithm prior to field HEMS. Limitations of this study included its single-center and retrospective design, small sample size, the absence of biomarkers (i.e. blood pressure, blood glucose, or heart rate) and the inconsistency of prehospital assessment documentation for stroke triage by HEMS. Future studies should focus on improving prehospital stroke triage tools to prevent unnecessary air transportation.

In conclusion, we found field HEMS to be associated with similar treatment rates, but faster treatment times, when compared to GEMS. Unfortunately, most field HEMS cases do not qualify for acute stroke reperfusion or neurosurgical interventions and may have been better triaged to GEMS to the closest local hospital for initial assessment.

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