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Helicopter EMS and its Outcomes in Stroke Patients during Transport from Rural ED to Comprehensive Stroke Center

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Abstract

The theory that will be examined in this review pertains to creating an algorithm based upon whether patients suffering from a stroke with a large vessel occlusion should be taken to a stroke center from rural emergency departments for a mechanical thrombectomy via helicopter EMS (HEMS) or ambulance transport. Such an algorithm does not exist in healthcare, so this literature review will have the potential to be clinically applicable. This review will aim to identify the proper method of transportation during an ischemic stroke with the goal of reducing mortality rates and improving outcomes. Most rural communities are over an hour away from the nearest hospital with a comprehensive stroke center. In time- sensitive events such as an ischemic stroke due to large vessel occlusion, outcome rates may be significantly lower in rural areas because local hospitals are distanced from tertiary stroke centers. The review was created using the following databases: PubMed, Google Scholar, and NCBI. Key search words: “Helicopter”, “EMS”, “stroke”, “tertiary”, “transport”. The results showed that the rates of thrombolysis were higher with HEMS when compared to ground ambulance transfer. HEMS has higher rates of thrombolysis, and thrombolysis is directly associated with better outcomes of stroke patients because the clot is being broken down. Long term cognitive function was significantly higher with HEMS and 90-day mortality was lower for HEMS patients versus ground transportation. Less time to thrombectomy was achieved with air transport in inter-hospital distances greater than 10 miles. Inter-hospital distances less than 10 miles yield better outcomes with ground transportation. Most rural hospital EDs are well over 10 miles from the nearest comprehensive stroke centers, which tend to be in urban areas. Therefore, rural HEMS is highly indicated to reduce these large hospital gaps.

Background

Stroke is the 5th leading cause of death in the United States, and the 1st leading cause of disability in adults.[1] Patients who suffer from an acute ischemic stroke are under a time-sensitive approach to obtain proper treatment in order to reduce permanent brain damage. When a patient first suffers from a stroke, they are admitted to a local hospital emergency department. At times, these local emergency departments do not have a comprehensive stroke center capable of treating these patients, especially in rural settings. Thus, patients are transferred to a tertiary emergency department with a stroke center that has the equipment necessary for mechanical thrombectomies. Unlike intravenous recombinant tissue plasminogen activator (rtPA) treatment, which is widely available, mechanical thrombectomy is a more invasive approach that is not widely accessible to approximately 20% of stroke patients, especially to those in rural areas or traffic-filled streets in cities. Mechanical thrombectomy is a time-sensitive treatment that could leave permanent brain damage if not performed within a specific window, so reducing transport times to tertiary emergency departments is critical. The distance between the local emergency department and the tertiary emergency department with a comprehensive stroke center is called “inter-hospital distance” and is the critical time-period that will be focused on in this literature review. This is where HEMS comes into play. The scope and impact of HEMS will be addressed, focusing on aspects such as hospital arrival time and patient outcomes in comparison to ground transport, especially in rural areas. The overall goal of this literature review is to study the outcomes of patients suffering stroke due to large vessel occlusion in rural areas depending on whether they receive helicopter or ground transport to a tertiary emergency department with a comprehensive stroke center.

Results

Outcome	HEMS group (n = 100)	Ground transportation group (n = 99)	*p* Value
Length of hospitalization in days, median (IQR)[a]	6 (4–12)	5 (3–9.5)	0.1
90-day mRS score, median (IQR)[b]	2.5 (1–4)	3 (1–5)	0.122
Good long-term outcome, n (%)[b]	45 (50)	35 (41.2)	0.242
90-day mortality, n (%)[b]	13 (14.4)	18 (21.2)	0.244

Abbreviations: IQR = interquartile range; HEMS = Helicopter Emergency Medical Services; mRS = modified Rankin scale.
[a] Available only for 190 patients.
[b] Available only for 175 patients.

Figure 1. This chart shows the outcomes of stroke patients in rural Georgia and South Carolina based on whether they received HEMS or ground transportation during inter-hospital transfer.

Inter-Hospital Distance	Time to Thrombectomy
> 10 miles	26.3 minutes
> 20 miles	35.1 minutes
> 30 miles	42.2 minutes

Figure 2. This chart shows the relationship between inter-hospital distance and time to thrombectomy from HEMS transfer.

HEMS transport patients had the highest rate of thrombolysis (29%) versus direct transfer (24%). What makes this relevant to the literature review is that these rates of thrombolysis were higher than ground ambulance transfer. Ground transfer had lower rates of thrombolysis at 15%.[2] Thus, according to these results, HEMS has higher rates of thrombolysis. Thrombolysis is directly associated with better outcomes of stroke patients because the clot is being broken down. The scale used to determine outcomes was the modified Rankin scale (mRS). A score of less than or equal to 2 represents long-term functional outcome, taken again at 90 days. The 90-day mRS score of HEMS patients was 2.5 whereas the score for ground transportation was 3.[3] As well, 90-day mortality was lower for HEMS patients versus ground transportation. It was found to be 13% 90- day mortality for HEMS versus 18% for ground transportation.[3] As inter-hospital distance increases, the time to thrombectomy increases less rapidly via HEMS transport versus ground transport.[4] This is only indicated in inter-hospital distances greater than 10 miles, however. For inter-hospital distances under 10 miles, ground transportation is indicated. The delay of inter-hospital transferred patients is associated with worse outcomes. Less time to thrombectomy was achieved with air transport with inter-hospital distances greater than 10 miles. Most rural hospital EDs are well over 10 miles from the nearest comprehensive stroke centers, which tend to be in urban areas.

Discussion

This literature review can help clinicians create an algorithm that decides which type of transport a patient should require during inter-hospital travel to a comprehensive stroke center. Inter-hospital distances over 10 miles should strongly consider HEMS, especially in rural areas where comprehensive stroke centers are sparse.[5] This review would be especially helpful to clinicians in rural areas due to the profound lack of comprehensive stroke centers. Patients suffering stroke due to large vessel occlusion will have better outcomes with a mechanical thrombectomy, which is a time-sensitive procedure that sometimes may not be indicated as a result of a large distance barrier in rural areas.[6] HEMS may bridge the gap between rural and urban centers, thus an algorithm to determine the correct transport type will be greatly beneficial to several Americans.

Conclusion

The use of HEMS in rural areas can significantly improve outcomes in patients suffering from stroke due to large vessel occlusion. Prior research has found that delays in inter-hospital transfer is associated with worse outcomes.[4] This may be because mechanical thrombectomies have a golden window of approximately 6 hours after the stroke occurs. Mechanical thrombectomies can only be performed in comprehensive stroke centers, which according to research can be over 60 minutes of ground transportation for a large proportion of the US population.[7] In fact, shorter transportation time was associated with higher odds of receiving mechanical thrombectomies likely because expedited transport results in higher likelihood of penumbra sustenance. The brain has collateral circulation that can provide backup blood supply in the unfortunate event of an ischemic attack. This collateral circulation is known as penumbra, which is only sustained for a short period of time. HEMS can reduce the time of inter-hospital transfer, therefore sustaining the penumbra, and allowing for mechanical thrombectomy to be effective in reducing patient disability. A previous study found that the odds of receiving mechanical thrombectomies decreases by 2.5% for every minute of delay during transfer.[8] This study confirms that stroke treatment is a very time-sensitive protocol which is why HEMS can be highly indicated in specific regions. This research can be applied to current medical practices in high-stroke volume centers, especially in rural areas. Rural ED physicians must make the decision to transfer patients to comprehensive stroke centers and the type of transportation they receive. Helicopter versus ambulance may seem like a trivial decision, but it may greatly affect outcomes in these patients. The major application of this literature review would be an algorithm to help make this important decision. Factors influencing this decision may be whether the patient is suffering stroke due to large vessel occlusion, what time the stroke occurred, the severity of the stroke, the mRS score, the NIHSS scale, the Glasgow Coma Score (GCS), and the inter-hospital distance to the nearest comprehensive stroke center. It is known that inter-hospital transfer time is a key and critical period which may affect the ability of patients to receive mechanical thrombectomies. Research has also found that HEMS is associated with shorter inter-hospital transfer time. Lastly, research has found that HEMS is associated with better long-term functional outcomes, decreased disability rates, and overall better transportation times. Future research should provide longer follow-up assessments to determine functional rates over 90 days post-stroke. Future clinical applications of this literature review can include state funding to rural areas for the increased infrastructure of comprehensive stroke centers to bridge the gap between rural and urban hospitals.

References

Available upon request.