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Lausanne, 14.12.2017

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Abstract

Background

Helicopter emergency medical services (HEMS) are popular rescue systems despite inconsistent evidence in the scientific literature to support their use. There is little research about inter-facility transfer (IFT) by HEMS, hence questions remain about the appropriateness of this method of transport. The aim of this study is to describe a case-mix's operational and medical characteristics for IFT activity of a sole HEMS base.

Methods

This is a retrospective study on HEMS IFT over 36 months, from January 1st, 2013 to December 31st 2015. Medical and operational data from the database of the Emergency Department of Lausanne University Hospital which provides the emergency physicians for this helicopter base were reviewed. It included time of transport compared to ground transport and type of care during flight.

Results

There were 2194 HEMS missions including 979 IFT (44.6%). Most transfers involved adults (> 17 years old) (799 patients, 81.6%). Forty patients (4.1% of total) were classified as having benefitted from resuscitation or life-saving measures performed in flight, 615 (62.8%) from an emergency treatment and 324 (33.1%) from a simple clinical examination. The overall mean distance by air in-between hospitals was 39.1 km (median 35.4 km). The overall mean distance by road was 56.0 km (median 47.7 km). The overall mean duration time from origin to destination by air was 14 min (median 12 min); by road it was 43 min (median 36 min).

Conclusions

A third of patients did not receive any treatment during flight, some other a continuous perfusion which itself may have motivated the activation of HEMS, and the median distance of travel of our case mix was <50 km. Although not all those HEMS missions can be classified as inappropriate, each system based on its own specificity needs to developed criteria to reduce overtriage

Keywords: Inter-facility transfer (IFT), helicopter emergency medical services (HEMS), case-mix

Background

Helicopter emergency medical services (HEMS) are popular rescue systems despite inconsistent evidence in the scientific literature to support their use [1–5]. Their main added value is speed of patient transport, ability to reach sites difficult to access and, in some HEMS, medical competences not available in ground ambulances (GAs). They can be used either for primary missions (transport from the scene to the hospital) or for inter-facility transfer (IFT) between hospitals to either upgrade the level of care (to a trauma centre or university hospital) or to downgrade the level of care (to make room in those trauma centres or university hospitals) [6].

In contrast to direct transport from the scene of injury, there is much less research about IFT by HEMS, hence questions remain about the appropriateness of this method of transport. Furthermore, research on this topic has been mainly limited to specific types of disease (STEMI, stroke, spinal injury) and not on whole HEMS case-mixes [7–9]. To our knowledge, there is no generally accepted guideline that would help choose the appropriate transport method for IFT.

The aim of this study is to describe the severity of a single HEMS IFT case-mix and compare the times of transport by helicopter versus those estimated by GA.

Methods

Setting

The State of Vaud (western Switzerland) has one trauma centre (Lausanne University Hospital), seven regional hospitals and many private clinics that are distributed equally over its territory. Most hospitals have a GA they can use for transfers. All GAs are staffed with emergency medical technicians or paramedics. They use state's protocols for autonomous intravenous access, cardiopulmonary resuscitation procedures, defibrillation and emergency medication administration. However, they are allowed to manage neither upper airway disposals (intubation, laryngeal mask or tube) nor continuous drug infusions (vasopressors, anaesthesia and sedation). These require the presence of an emergency physician (EP). EPs are scarcely available to conduct IFT by GA as hospital want to keep this scares resources within their EDs, HEMS which are staffed with their own EP and paramedic are regularly used to assume those transfers. Switzerland is very well covered for its area of 41,300 square kilometres (16,000 square miles), with 20 medically equipped helicopters from private companies during daytime, and 12 during night-time. In our region, requests for HEMS IFT are made by the hospital medical team in charge of the patient; there is no triage either from the HEMS companies or from dispatch centres regarding secondary transport.

Study design

This is a retrospective study, carried out on data from January 1st 2013 to December 31st 2015 (36 months). All data were extracted from the database of the Emergency Department of the Lausanne University Hospital which staffs the EPs for this HEMS. Prehospital medical charts are filled in by EPs and then checked by medical supervisors.

Measurements and outcomes

Demographics (age and sex), diagnosis and operational data (distances, origin and destination, date, time of day and duration of transfers) were collected. Patients 17 years of age and under were included into a pediatric subgroup. Outcome at 48 h (mortality, ICU or ward stay, discharge) were obtained from hospital charts. Diagnosis was grouped into nine clinical categories (*heart and vessel disease*, *traumatology*, *neurology*, *pneumology*, *obstetrics*, *paediatrics*, *toxicology*, *psychiatry* and *miscellaneous*). Patient care provided during transfer was classified into three care categories by EPs: *simple clinical examination*, *emergency treatment* and *resuscitation or life-saving manoeuvres*. Simple clinical examination consisted of simple monitoring of the patient during the flight. Emergency treatment consisted of administering any medication including fluid resuscitation, even if it was started in the hospital, or to pursue ongoing ventilation. Resuscitation consisted of gestures and manoeuvres necessary to maintain the patient's life, such as cardiac massage, defibrillation or intubation. Distances of the journey by road were calculated with Google Maps®. To estimate the duration of travel by road, we removed artificially 20% of the estimated time proposed by Google Maps®, considering that for urgent medical transfers, GAs would use lights and sirens.

Data were integrated into an Excel® spreadsheet, and were processed and analysed using Stata© (Stata, Statistical Software 14.2, Stata Corporation, College Station, TX, USA).

Results

During the study period, there were 2194 HEMS missions including 982 IFT (44.8%). Three patients were excluded as they died before take-off; 979 were finally included (Fig. 1) (Table 1). There were 772 (78.9%) transfers from regional hospitals to a university hospital, 139 (14.2%) from a university hospital to a regional hospital, 36 (3.7%) from a regional hospital to another regional hospital and 32 (3.3%) from a university hospital to another university hospital. Most missions involved adults (> 17 years old) (799; 81.6%). Forty patients (4.1% of total) were classified as having benefitted from *resuscitation or life-saving measures* performed in flight, 615 (62.8%) from an *emergency treatment* and 324 (33.1%) from a *simple clinical examination*. Table 2 lists the fate of all patients at 48 h, regarding the type of care performed *en route*. The majority of patients were hospitalized in an intensive care unit (ICU) regardless of the type of care received.

Operational characteristics (Table 3)

The overall mean distance by air in-between hospitals was 39.1 km (median 35.4 km). The overall mean distance by road calculated with Google Maps® was 56.0 km (median 47.7 km). The overall mean duration from origin to destination by air was 14 min (median 12 min); by road it was 43 min (median 36 min).

The number of missions was stable over the week; a slight reduction in missions from June to October was observed. There were 270 (27.6%) transfers during weekends, and 361 (36.9%) night transfers (7 pm–7 am).

Discussion

As mentioned, the main added value of HEMS regarding IFT, theoretically, is speed of patient transport, and sometimes medical competences not being available in GAs, which is the case in our EMS. In this 979-case HEMS inter-facility case-mix, most patients transported (615; 62.8%) benefitted from an *emergency treatment*, not available in a GA; for those, as long as neither EPs are available in GAs nor paramedics are allowed to take care of continuous infusions and ventilation, those HEMS missions can probably be considered as appropriate in our EMS. However, efficiency could be improved by certifying that those treatments are absolutely required during transport; some continuous medication can sometimes be stopped transiently and therefore may allow the type of care and or transport to be simplified.

The *simple clinical examination* group included 324 patients (33.1%). For those, the only possible added values of HEMS were speed of transport and/or medical presence if the clinical situation was unstable. Some of them may have needed HEMS to exclude and/or treat a time-sensitive condition (STEMI, stroke, angiography, neurosurgery) which it was not possible to do in local hospitals. It is possible that some stroke or STEMI patients may have received all necessary treatment before being transferred to a higher level of care, and therefore no longer needed advanced surveillance by an EP. When analysing in detail the diagnosis declared by EPs for this category, we can retrospectively suppose that some of them may not have needed HEMS (head trauma with GCS 14, spine trauma without neurological deficit, pneumonia, intoxication, alcohol abuse, …).

If speed of transport is the motivation to use HEMS, we should be reminded that although a helicopter can cover a greater distance than a GA in a given time, it is not always the fastest method of transfer. [5] Indeed, it takes longer to install a patient in a helicopter than in a GA. Take-off and landing procedures also take longer than starting an ambulance engine [10]. In our area, many hospital landing zones are located on roof tops or at some distance from emergency departments. Finally, it should be mentioned that most hospitals have a GA service nearby, which may be at the patient's bedside somewhat quicker than HEMS.

Regarding the delay issue, some have proposed using distances in-between hospitals or expected duration of transfer to request HEMS [11,12], but there is no consensus on a cut-off distance for which the helicopter should be used [5]. It will depend on the configuration of each EMS and its geography (mountains, water). Kristiansen et al. showed an increase in the use of HEMS proportional to the distance to be covered, and a decrease in mortality for transfers by HEMS ≥ 100 km [11]. Another study recommends considering HEMS for distances ≥ 30 km by route, for IFT and for primary missions [12]. If we transpose this value to our study, we note that 738 missions were above that proposed limit. Finally, following the loss of their helicopter in a crash accident, Mann et al. [8] showed a significant increase in transfer duration with GAs without an increase in the mortality of non-transferred patients. This demonstrates that a more conservative approach can sometimes be chosen.

The outcome at 48 h shows that 425 (43.4%) patients were hospitalized in ICU. That demonstrates the severity of our case-mix but cannot retrospectively help to draw guidelines for the use of HEMS in IFT; a clinical evaluation performed immediately on arrival would be more helpful.

There were few trauma cases in this case-mix. This could be explained by efficient sorting performed during on-scene missions, and a consequently low retransfer rate, as previously published for our HEMS [13].

Regarding night flights, it is well documented that they involve increased risks; 49% of accidents occur at night, while night flights account for only 38% of all flights [14]. Our night flight rate is similar. HEMS should only be used when the benefits for the patient outweigh the risks, especially for night IFT.

Some studies have described factors (distance, geography) that influence the use of HEMS for IFT [15–17], while others demonstrated either a survival advantage [1,8,18,19] or disadvantage [2,17] for injured patients. The decision to use HEMS is a sensitive topic, and there is no unambiguous evidence in favour or against its use for IFT in the literature; studies are carried out in different health policy settings and in different geographical environments, and their results cannot be directly transposed to other EMS. Moreover, most of these studies take into account only one category of pathologies and not the whole case-mix [9,15]. This is made even more difficult in our system by the fact that there is no independent dispatch decision on transfer; the hospital physician can solely decide to use it, and they are often not aware of paramedic competences. Ideally, a dispatch centre should decide to allow HEMS for transfers or not, based on the need of HEMS for primary missions, the patient's condition, the suspected pathology and time gained by using HEMS for IFT. But this would require advanced medical competences within the dispatch centre.

To better understand the use of the HEMS for IFT and thus to be able to propose new guidelines, it should be mandatory to prospectively document the reason a physician chooses HEMS instead of GA, if it is a matter of speed or level of care. It is also necessary always to evaluate if ongoing continuous treatment can be stopped transitorily or not. Finally, if dispatch centre staff were competent to decide whether to use HEMS for IFT, this may contribute to reduce over-use of HEMS for IFT. There will always be a certain amount of over-triage in the use of HEMS for transfer, and we should accept it. The question, as always, is how much is too much?

Limitations

This is a monocentric and retrospective study. The data available could not define if primary missions needing HEMS had to go by ground because of transfer activity with the helicopter. The reason physicians required HEMS instead of a GA for transfer is not known, as it is not documented in hospital or prehospital charts. The category use to describe the treatment received during flight is not a validated standard. Time and distances were estimated using Google Maps®. The elapsed time between HEMS activation and arrival at the hospital was not described, as many transfers were 'scheduled'. Only the duration of transport by HEMS were measured, not the entire process from the alarm to the arrival of HEMS at the receiving facility. This study took place in a specific setting (geography, paramedic autonomy, absence of EPs in GAs), and may not be applicable elsewhere.

Conclusions

HEMS has an indisputable added value for some primary missions. It probably also adds value to some IFTs. But as noticed in this study, when looking at the treatment received during the flight or the distances of transport, we can suspect there is some overtriage. Physicians in hospitals are often not aware of the limits of HEMS for IFTs but they can decide if the helicopter is the best vector of transport. We lack validated clinical criteria as well as local criteria related to geography, paramedic autonomy and GA availability to help them decide when to use HEMS for IFTs.

List of abbreviations

EP: emergency physician

EMS: Emergency medical service

HEMS: Helicopter emergency medical service

ICU: Intensive care unit

IFT: Inter-facility transfer

STEMI: ST-elevation myocardial infarction

GA: Ground ambulance

ISS: Injury severity score

Declarations

Ethics approval

This study was authorized by the Lausanne University Ethics Committee for Human Research and by the state's Public Health Service (CER-VD 2016-00995).

Acknowledgements

None.

Funding

None.

Availability of data and materials

The data generated or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

DDR generated, analysed and interpreted the data, and was a major contributor in writing the manuscript. FD analysed and interpreted the transfer data, and was a major contributor in writing the manuscript. PNC, EA and MP critically revised the manuscript for important intellectual content, and approved the final version to be published. All authors read and approved the final manuscript.

Consent for publication

Not applicable.

Competing interests

None.

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Figure

Fig. 1 Inter-facility transfer flowchart

SCE: simple clinical examination, ROSM: resuscitation or life-saving manoeuvres, ET: emergency treatment, AV: assisted ventilation (intubated/tracheotomized)

*not transported: died before take-off

Tables

Table 1 Patients' clinical characteristics

Clinical characteristics: demographic indicators, medical equipment according to the type of care and clinical categories are described. All the percentages refer to the 979 patients included

SD: standard deviation, GCS: Glasgow Coma Scale, TBI: traumatic brain injury

*Continuous drugs used: norepinephrine, dopamine, dobutamine, propofol, clonidine, sodium nitroprusside, labetalol, alteplase, heparin, isosorbide dinitrate, nitroglycerin, atosiban

Table 2 Patients' fate at 48 hours

Patients' fate at 48 h after inter-facility transfer by HEMS. The fate is described according to the type of care provided by the transfer team

Table 3 Operational characteristics

Operational characteristics including distances and times by HEMS as well as by road (estimated with Google Maps®). The flow of transfers by type of care, and the volumes of transfers per month and per day are also described. IQR: interquartile range

*Expert recommendation by Kim et al. study, ¶expert recommendation by Kristiansen et al. study

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Table 1 Patients' clinical characteristics (n=979)

Demographic		
All		
n (%)		979 (100)
Gender male, n (%)		594 (60.7)
Age (mean ± SD) (range)		50.7 ± 26.9 (1–95)
Adults		
n (%)		799 (81.6)
Gender male, n (%)		487 (49.7)
Age (mean ± SD) (range)		60.8 ± 18.1 (18–95)
Paediatric patients		
n (%)		180 (18.4)
Gender male, n (%)		107 (10.9)
Age (mean ± SD) (range)		6.1 ± 5.1 (1–17)
Care category (= n) (%)		
Simple clinical examination		**324 (33.1)**
Intubated before transfer		0 (0)
Tracheotomized before transfer		0 (0)
Infusion pumps		0 (0)
Emergency treatment		**615 (62.8)**
Intubated before transfer		205 (20.9)
Tracheotomized before transfer		20 (2.0)
Infusion pumps		295 (30.1)

Resuscitation or life-saving measures		**40 (4.1)**
Intubated before transfer		23 (2.3)
Tracheotomized before transfer		0 (0)
Infusion pumps		17 (1.7)
Clinical category (= n) (%)		
Heart/vessel disease		**252 (25.7)**
Myocardial infarct		103 (10.5)
Chest pain		38 (3.9)
Cardiac arrest		28 (2.9)
Cardiac insufficiency		17 (1.7)
Aortic abdominal aneurysm ruptured		14 (1.4)
Other		52 (5.3)
Traumatology		**152 (15.5)**
Mild TBI (GCS 14–15)		29 (3)
Blunt abdominal trauma		24 (2.5)
Moderate TBI (GCS 9–13)		13 (1.3)
Severe TBI (GCS 3–8)		13 (1.3)
Other trauma		73 (7.5%)
Neurology		**123 (12.6)**
Stroke		85 (8.7)
Status epilepticus		16 (1.6)
Epilepsy		14 (1.4)
Other		8 (0.8)
Pneumology		**85 (8.7)**

Obstetrics		**58 (5.9)**
Paediatrics		**46 (4.7)**
Toxicology		**25 (2.6)**
Psychiatry		**3 (0.3)**
Miscellaneous		**235 (24)**

Table 2 Patients' 48 hours outcome

		Type of care		
Outcome at 48 h (= n)/	**Total (n = 979)**	**Simple clinical examination (n = 324) (33.1%)**	**Emergency treatment (n = 615) (62.8%)**	**Resuscitation or life-saving measures (n = 40) (4.1%)**
Hospitalized in intensive care unit	425 (43.4)	75 (7.7)	325 (33.2)	25 (2.6)
Hospitalized in intermediate care unit	196 (20)	96 (9.8)	96 (9.8)	4 (0.4)
Hospitalized in ward division	181 (18.5)	70 (7.2)	108 (11.0)	3 (0.3)
Transfer to another institution	88 (9)	42 (4.3)	45 (4.6)	1 (0.1)
Hospitalized and returned home	44 (4.5)	34 (3.5)	10 (1.0)	–
Not hospitalized, discharged	9 (0.9)	4 (0.4)	5 (0.5)	–
Died: 0–1 h (after admission)	3 (0.3)	1 (0.1)	–	2 (0.2)
Died: 1–6 h	3 (0.3)	–	3 (0.3)	–
Died: 6–24 h	19 (1.9)	–	14 (1.4)	5 (0.5)
Died: 24–48 h	11 (1.1)	2 (0.2)	9 (0.9)	–

Table 3 Operational characteristics		
	HEMS	**Road (estimated)**
Total missions, n	979	979
Mean distance (km) (median, range, IQR)	39.1 (35.4, 9.6–231.7, 22.5-–40.2)	56.0 (47.7, 19.0–396.0, 30.5–71.1)
< 30 km, n (%)*	342 (34.9)	241 (24.6)
≥ 100 km, n (%)	37 (3.8)	70 (7.1)
Mean duration (min) (median, range, IQR)	14 (12, 3–93, 10–15)	43 (36, 18–262, 27–49)
Flow of transfers & clinical classification		
University to university	32 (3.3%)	
Simple clinical examination	6 (0.6)	
Emergency treatment	26 (2.7)	
Resuscitation or life-saving measures	0 (0)	
Regional to regional	36 (3.7%)	
Simple clinical examination	14 (1.4)	
Emergency treatment	21 (2.1)	
Resuscitation or life-saving measures	1 (0.1)	
University to regional	139 (14.2%)	
Simple clinical examination	39 (4.0)	
Emergency treatment	98 (10.0)	
Resuscitation or life-saving measures	2 (0.2)	

Regional to university	772 (78.9%)	
Simple clinical examination	265 (27.1)	
Emergency treatment	470 (48.0)	
Resuscitation or life-saving measures	37 (3.8)	
Night mission 7 pm–7 am	361 (36.9%)	

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Figure 1