A 5-year analysis of the helicopter air mercy service in Richards Bay, South Africa

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Background. A helicopter emergency medical service (HEMS) was established in 2005 in Richards Bay, KwaZulu-Natal, South Africa, to provide primary response and inter-facility transfers to a largely rural area with a population of 3.4 million people.
Objective. To describe the first 5 years of operation of the HEMS.
Methods. A chart review of all flights from 1 January 2006 to 31 December 2010 was conducted.
Results. A total of 1 429 flights were undertaken; 3 were excluded from analysis (missing folders). Most flights (88.4%) were inter-facility transfers (IFTs). Almost 10% were cancelled after takeoff. The breakdown by age was 61.9% adult, 15.1% paediatric and 21.6% neonate. The main indications for IFTs were obstetrics (34.5%), paediatrics (27.9%) and trauma (15.9%). For primary response most cases were trauma (72.9%) and obstetrics (11.3%). The median on-scene time for neonates was significantly longer (48 min, interquartile range (IQR) 35 - 64 min) than that for adults (36 min, IQR 26 - 48; $p<0.001$) and paediatrics (36 min, IQR 25 - 51; $p<0.02$). On-scene times for doctor-paramedic crews (45 min, IQR 27 - 50) were significantly longer than for paramedic-only crews (38 min, IQR 27 - 57; $p<0.001$).
Conclusion. The low flight-to-population ratio and primary response rate may indicate under-utilisation of the air medical service in an area with a shortage of advanced life support crews and long transport distances. Further studies on HEMSs in rural Africa are needed, particularly with regard to cost-benefit analyses, optimal activation criteria and triage systems.

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Emergency medical care in Africa can have a significant impact on healthcare outcomes at a lower cost than other interventions. It basically consists of a pre-hospital and an in-hospital phase.[1] The pre-hospital phase includes two equally important components: (*i*) the care provided at the incident scene; and (*ii*) the actual transportation of patients to healthcare facilities.[1]

The transportation phase occurs in an unstable out-of-hospital environment that could be deleterious to the patient's condition; it should therefore be minimised as much as possible. Helicopters have been used in civilian operations since the 1960s, but despite their widespread use as part of emergency medical services (EMS), some debate continues regarding their cost-effectiveness and optimal utility.[2,3]

There are multiple benefits of a helicopter EMS (HEMS): rapid transportation, direct transport to definitive treatment rather than the nearest medical facility, getting more highly skilled personnel to the scene, and access to areas inaccessible by road.[4] On the other hand, helicopters are expensive, cannot fly in adverse weather conditions, may be unable to fly at night, and cannot transport patients with certain conditions, e.g. women in active labour.[5]

The optimal use of a HEMS (with regard to cost-effectiveness and patient benefit) depends on the broader EMS system in which the HEMS operates.[6] Determining how best to incorporate a HEMS in each system should be done at a local level, as patient populations differ from region to region. Rural HEMSs in Europe and Japan transported a preponderance of medical and trauma patients,[7,8] while obstetrics and gynaecology patients dominated in New Zealand.[9] Descriptive studies of this nature permit assessment of the utility of a HEMS and are therefore important when deciding whether to extend or improve services.[7,8]

This study describes the use of a HEMS in a rural African setting during its first 5 years of operation.

Methods

Study setting

The South African Red Cross Air Mercy Service (AMS) operates eight bases in South Africa (SA). We evaluated data from the Richards Bay base in KwaZulu-Natal (KZN) that provides aeromedical services to northern KZN, a rural area with a population of 3.4 million[10] and severe shortages of appropriately trained pre-hospital staff and equipment. The average ambulance coverage in KZN is 1/44 000 people (recommended national standard 1/10 000), while only 5% of EMS staff are trained in advanced life support (ALS) (recommended national standard 15%).[10]

The Richards Bay AMS base operates 365 days a year from 07h00 to sunset (as of 2012 the service has had limited night capability). The helicopter crew consists of a pilot and two healthcare providers, one of whom is at least an ALS paramedic. Every Tuesday, a doctor from the area's referral hospital (Ngwelazana Hospital) forms part of the two-man medical crew.

Study design

A retrospective chart review of all activated flights from the first 5 years of the Richards Bay AMS base (1 January 2006 - 31 December 2010) was conducted. Ethics approval was obtained from the Stellenbosch University Health Research Ethics Committee (ref. S12/02/035) and permission was obtained from the SA Red Cross AMS management team.

Study population

All flights activated for transporting a patient were included. Flights with missing records were excluded. In the event of incomplete documentation, the cases were not excluded; instead, only the specific missing variable was indicated as not specified.

Data collection and management

Data were collected from patient report forms and pilots' flight logs. A summarised record of all flights is also kept at the AMS base and was compared with the patient report forms to identify any missing flights. The principal investigator entered the data onto an electronic spreadsheet (MS Excel).

Patients were categorised according to the age group classifications used by the KZN Department of Health: adult >12 years, paediatric 28 days - 12 years, and neonate <28 days. The triage coding used was: red – immediate life-threatening condition; yellow – urgent but not immediately life-threatening condition; green – non-urgent condition; and blue – dead. This coding was based on the practitioner's subjective assessment of the patient and was performed upon loading the patient into the helicopter.

For clarity, the following definitions were used: (*i*) inter-facility transfer (IFT): flights that transported patients from one healthcare facility to another; (*ii*) primary response: flights where the helicopter was used to respond to a pre-hospital scene directly; (*iii*) stood-down flights: flights where the helicopter was activated but cancelled before landing at the scene; (*iv*) not-transported flights: flights where the helicopter landed at the scene but no patient was transported; and (*v*) on-scene time: the time between landing and taking off from the pre-hospital scene or healthcare facility.

Statistical analysis

Statistical analysis was performed by the Centre for Statistical Consultation at Stellenbosch University. STATISTICA version 10 was used. Descriptive statistics were used to fulfil the aim. Medians and interquartile ranges (IQRs) were used to describe the on-scene times. Categorical and binary data were presented using frequency tables and proportions. Inferential statistics were calculated using the Mann-Whitney *U*-test when comparing continuous binary variables and the Kruskal-Wallis test for comparing continuous nominal variables. Bonferroni adjustments were done for multiple comparisons. A *p*-value of ≤0.05 was considered significant.

Table 1. Indications for requesting helicopter transportation

	All flights *n* (%)	Inter-facility transfer *n* (%)	Primary response *n* (%)
Obstetric	413 (32.1)	398 (34.5)	15 (11.3)
Paediatric	331 (25.7)	322 (27.9)	9 (6.8)
Trauma	280 (21.8)	183 (15.9)	97 (72.9)
Surgery	117 (9.1)	115 (10.0)	2 (1.5)
Medical	105 (8.2)	101 (8.8)	4 (3.0)
Other*	41 (3.2)	35 (3.0)	6 (4.5)

*Poisoning, environmental conditions and snakebites.

Results

A total of 1 429 flights were undertaken during the 5-year study period. Three records were missing, leaving 1 426 flights accessible for analysis. Of these, 165 flights (11.6%) were primary responses and 1 253 (88.4%) IFTs (8 flights had incomplete data). The number of flights peaked during 2007 (2006 *n*=195, 2007 *n*=396, 2008 *n*=348, 2009 *n*=252, 2010 *n*=278).

A total of 1 287 flights transported patients (90.3%). Sixty-nine flights (4.8%) were stood down (IFT *n*=39, primary *n*=23, unknown *n*=7) and 70 flights (4.9%) did not transport any patients (IFT *n*=60, primary *n*=9, unknown *n*=1). Proportionally more stood-down and not-transported flights were in the primary response group (19% v. 8%). The main reasons for stood-down flights were bad weather (*n*=39) and patients already transported by other means (*n*=21), while for not-transported flights, 47 patients died before loading and 15 were not fit for flight.

Adult patients were transported most (*n*=797, 61.9%), followed by neonates (*n*=278, 21.6%) and paediatric patients (*n*=194, 15.1%). Almost 19% of patients (*n*=243) were <7 days old. Neonates were predominantly IFTs (*n*=275, 98.9%). Age was not noted in 18 flights.

The predominant indications for requesting the helicopter were related to obstetrics and gynaecology (*n*=413, 32.1%), paediatrics (*n*=331, 25.7%) and trauma (*n*=280, 21.8%) (Table 1).

The majority of patients were triaged yellow (*n*=778, 60.5%; IFT 708, primary 70), just over a fifth were triaged red (*n*=291, 22.6%; IFT 246, primary 45), and only 9 (0.7%) were triaged green (IFT 7, primary 2). One patient died (0.1%), while 208 flights (16.2%) had incomplete data (IFT 193, primary 15).

The median flight time from base to pre-hospital scene or healthcare facility was 35 min (IQR 26 - 50) for IFTs and 22 min (IQR 14.5 - 33.5) for primary responses. The flight time from pre-hospital scene or healthcare facility to destination was 35 min (IQR 25 - 50) for IFTs and 15 min (IQR 8 - 25) for primary responses.

The overall median on-scene time was 39 min (IQR 27 - 51). The median on-scene time for primary response (23 min, IQR 13 - 32) was shorter than the 40 min (IQR 30 - 53) for IFTs. There was no significant difference in median on-scene time between adult (36 min, IQR 26 - 48) and paediatric patients (36 min, IQR 25 - 51; *p*=1.0). However, neonates (48 min, IQR 35 - 64) had much longer on-scene times than paediatric (*p*<0.02) and adult (*p*<0.001) patients.

The presence of a doctor on board was associated with a statistically significant increase in on-scene time (45 min, IQR 27 - 50) compared with flights without a doctor on board (38 min, IQR 27 - 57; *p*<0.001).

Discussion

The Richards Bay AMS base averaged 285 flights per year over the 5-year period. In terms of absolute numbers this is similar to other rural HEMSs (Japan 314 flights per year; Sweden 314 flights per year).[7,8] However, when the number of flights per population served was compared, the Richards Bay service has 1 flight per 11 930 people per year compared with 6 622 people per year in Japan and 828 people per year in Sweden.[7,8]

There are several possible explanations for our low flight request rate. Firstly, the EMS system in rural KZN has severe staff shortages resulting in prolonged response times by ground crew (only 50% of rural response times for red-coded patients by road were less than 40 min in 2009).[10] Additionally, at the time of the study the helicopter could only be activated once road crew had reached the scene; it can therefore be argued that severely injured polytrauma patients were dying on-scene before the helicopter could be activated. Secondly, many of the hospitals are staffed by unsupervised junior doctors who may underestimate a patient's condition, therefore not requesting HEMS.[11] Thirdly, many patients in this area prefer to seek help from traditional healers first and may present late in the course of disease, so that referral will no longer be of benefit.[12] Finally, doctors could be under the impression that the cost of HEMS is restrictive and therefore do not think to make use of it.

The last statement reflects the lack of awareness of HEMS funding in the public service. The KZN Department of Health pays a fixed monthly fee that covers the fixed overheads of the HEMS service and includes the cost of 30 flight hours (at R22 667 per hour). Any additional flight hours only incur costs for fuel and aircraft maintenance (at R6 008 per hour). When this cost is compared with the cost of running an ALS-equipped road ambulance (at R25.51 per km), with greater distances, the helicopter becomes a cost-effective means of transporting patients (personal communication, Mr Neil Gargan, General Manager, South African Paramedic Services). In addition, utilising a HEMS leaves the ground crew present in the area to continue to handle local calls.

Primary response comprises 65% of other rural HEMS activations, and is significantly higher than the 12% in this study.[7,8] As mentioned above, the HEMS in KZN currently uses a two-tiered system and alternative methods of primary activation of HEMS should be actively explored (subsequently, efforts have been undertaken to facilitate earlier activation). Algorithms have been designed to assist in deciding on the need for primary air transport in the UK, and the development of such an algorithm for an African setting should be investigated.[5]

The percentage of stood-down and not-transported flights (10%) is similar to those in other countries (8 - 17%).[7-8] These flights add cost without patient benefit and should be limited as far as possible. Poor weather conditions cannot be avoided, but situations such as 'no receiving bed' for the patient requiring HEMS are not acceptable.

Obstetrics and gynaecology, paediatrics and trauma were the three most common indications for flight (trauma was the most common in primary response). This was expected, as SA has a high injury-related burden of disease and obstetric and paediatric patients often require specialised care only available at referral hospitals.[13] Given the HIV/AIDS epidemic, more medically related transfers might have been expected, but cases can generally be managed in peripheral centres.[13] The flight indications in rural KZN are similar to those in New Zealand, highlighting the fact that a HEMS should be integrated with a well-developed EMS system specifically designed for local epidemiology.[7,9]

The proportion of patients with life-threatening conditions was low in this study (23% of patients triaged red) compared with 55% in other HEMSs.[7] Triage was done subjectively and severity might have been under-estimated, suggesting that a more objective triage scale is needed for HEMSs in SA.

The prolonged on-scene time for a neonate (48 min) is comparable with international times (38 min) and reflects the difficulties of transporting patients in this age group.[14] There are several potential explanations for this prolonged on-scene time, including the helicopter crew not being well prepared to deal with neonates, inadequate equipment for neonates, and failure of hospital staff to prepare neonates adequately for transport.

The optimal use of doctors as part of the HEMS crew has long been debated. Doctors can add benefit on-scene through their decision-making capabilities and by performing advanced interventions.[15] However, staffing an HEMS with a doctor increases costs and their presence is associated with slightly longer on-scene times.[4]

Study limitations

There was no external method available to confirm the data as entered onto the database. Errors may have occurred in transcription from the patient report forms, and the data on the forms may have been inaccurate in the first place. While this may introduce error into the magnitude of the results, we do not believe that the overall conclusion is affected.

Conclusion

This study of a rural African HEMS has shown a much lower flight per population ratio than in other rural HEMSs around the world. There is also a much lower incidence of primary responses. This may indicate that the HEMS is an underutilised modality in a setting where it could have major impact, especially considering the shortage of ALS ground crew. The patient profile differed from other rural HEMSs, is representative of Africa's burden of disease, and may be expected to be the same in other rural African HEMSs. Training and equipment, specific to the African environment, for the management of obstetrics, paediatrics (especially neonates) and trauma patients should be provided to flight crew.

There is a need for further studies on HEMSs in rural Africa, looking at cost-benefit analyses, optimal activation criteria and triage systems in particular.

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