

# **A FIVE YEAR ANALYSIS OF THE ROTOR WING AIR MERCY SERVICE IN RICHARDS BAY, SOUTH AFRICA**

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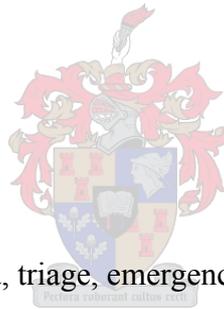
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## ABSTRACT

**Introduction:** The study describes the first five years of operation of a HEMS service in rural South Africa.

**Methods:** A chart review of all activated flights from 1 January 2006 to 31 December 2010 was conducted. Flights with missing patient report forms were excluded. Data collected included age, indication for flight, triage code, flight times, on-scene times, presence of doctor as part of crew, and whether the flight was for a primary response or inter-facility transfer.

**Results:** 1429 flights were undertaken; three records were missing. Primary response accounted for 165 (11.57%) of flights. 139 (9.75%) flights were cancelled after take off (Interfacility Transfer (IFT) n=99, 7.9%; Primary n=32, 19.4%; unspecified n=8). Just over a third (n=472, 36.67%, IFT n=447, 38.74%; Primary n=25, 18.80%) of patients were under twelve years old. The main indications for flight in IFT were obstetrics (n=398, 34.49%), paediatrics (n=322, 27.90%), and trauma (n=183, 15.86%). In primary response trauma (n=97, 72.93%) was most common followed by obstetrics (n=15, 11.28%), and paediatrics (n=9, 6.78%). However the triage system used appeared to be subjective and inconsistent. There was a significantly longer median on-scene time for neonates (48 minutes, IQR 35-64 minutes) as compared to adults (36 minutes, IQR 26-48 minutes,  $p<0.001$ ) and paediatrics (36 minutes, IQR 25-51 minutes,  $p<0.02$ ). On-scene times for doctor-paramedic crews (45 minutes, IQR 27-50) were significantly longer than paramedic only crews (38 minutes, IQR 27-57,  $p<0.001$ ).

**Conclusion:** The low flight per population ratios and primary response rate may indicate under-utilisation of HEMS in an area where it may have a major impact considering the shortage of ALS crew and the long transport distances. There is a need for further studies into HEMS in rural Africa, looking particularly at cost-benefit analyses, optimal activation criteria, and triage systems.

## **INTRODUCTION**

Emergency medical care in Africa can have a significant impact on healthcare outcomes at a lower cost than other interventions. (1) Despite this, emergency medical care has been neglected as part of public health planning in Africa. (1)

Emergency medical care consists of care at the incident scene, transport of the patient to the hospital, and hospital care. (2) Care at the incident scene can be provided by emergency first aid responders or by qualified pre-hospital personnel. (3) In low-income countries and rural areas, transport from the scene to the hospital is often performed by commercial drivers and lay persons. (4) More developed EMS systems provide pre-hospital personnel to transport patients to the hospital, using either ground or air ambulances.

Helicopters have been used to provide on-scene care and transportation of patients in civilian operations since the 1960's. (5) Despite the widespread use of Helicopter Emergency Medical Systems (HEMS) there is still debate regarding its' cost effectiveness and optimal utility. (6) HEMS benefits include rapid transportation, the provision of an increased level of care at the scene, transport to definitive treatment rather than the nearest medical facility, and access to areas inaccessible by road. (7) Factors against the use of HEMS are that the helicopter cannot fly in adverse weather conditions, a helicopter may be unable to fly at night, and a helicopter cannot transport an agitated or violent patient, or a patient in active labour. (8)

The optimal use of HEMS for both cost-effectiveness and benefit will depend on the system in which HEMS operates. (9) As such, determining how best to incorporate HEMS in each system should be done at a local level.

Studies of rural HEMS in Europe and Japan have shown a preponderance of medical and trauma indications (10,11), while a rural HEMS study from New Zealand reflected a dominance of obstetrics and gynaecology patients. (12) All of these services had a physician as part of the crew. Descriptive studies of this nature allow one to assess the helicopters utility and can aid in making recommendations to extend and improve services. (10,11)

To our knowledge there have been no studies looking at rural African HEMS.

The aim of this study was to describe the use of HEMS in a rural African setting during its first five years of operation. As secondary objectives we compared on-scene times between different age groups of patients and between days when there was and wasn't a doctor as part of the crew.

## **METHODS**

### **Study Setting**

The South African Red Cross Air Mercy Service (AMS) operates eight bases. We evaluated data from the Richards Bay AMS base which is situated in KwaZulu-Natal (KZN) and provides primary response and interfacility transfer services to northern KZN, a rural area with a population of 3.4 million people. (13) KZN has a shortage of emergency service personnel and equipment. In South

Africa the national standard of ambulance coverage is 1:10 000 population. (13)The KZN average is 1:44000. (13) An allocation of 10 EMS personnel per ambulance, with 15% of these being advanced life support (ALS) trained, is also a national standard. (13) In KZN only 5% of EMS staff is ALS trained. (13)The Richards Bay HEMS is operating in an area where there is a severe shortage of pre-hospital staff and equipment.

The Richards Bay Base operates 365 days a year from 7am to sunset (as of 2012 the service has had limited night capability). The helicopter is crewed by a pilot and two medical practitioners, one of which is at least an advanced life support paramedic. Every Tuesday, a doctor from the area's referral hospital (Ngwelazana Hospital) replaces one of the crew.

### **Study Design**

This was a retrospective chart review of all activated flights from the first five years of the Richards Bay AMS base (1 January 2006 to 31 December 2010). Ethics approval was obtained from the University of Stellenbosch Health Research Ethics Committee (Ref: S12/02/035). Permission was also obtained from the Red Cross AMS management team.

### **Study population**

All flights activated for transporting a patient were included. Flights with missing records were excluded.

### **Data collection and management**

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

Patients were divided according to age group: adult >12, paediatric 28 days to 12 years old, and neonate < 28 days (these are the age group classifications used by the department of health in KZN).

The triage coding used was: Red – immediate life-threatening condition, yellow – urgent but not immediately life-threatening condition, green – non-urgent condition, blue – dead. This coding was based on the practitioner's subjective assessment of the patient.

For clarity, the following definitions were used:

- Inter-facility transfer - flights which transported patients from one healthcare facility to another.
- Primary response - where the helicopter was used to respond to a scene directly.
- Stood-down flights - where the helicopter was activated but was cancelled before landing on-scene.
- Not-transported flights - where the helicopter landed on-scene but no patient was transported.
- On-scene time - the time between the helicopter landing on-scene and taking off from scene (on-scene includes hospitals for inter-facility transfers).

### Statistical analysis

Statistical analysis was performed by the Centre for Statistical Consultation at the University of Stellenbosch. STATISTICA version 10 (StatSoft Inc. (2011) STATISTICA (data analysis software system, [www.statsoft.com](http://www.statsoft.com).) was used. Descriptive statistics were used to fulfil the aim. Medians and interquartile ranges were used to describe the on-scene times. Categorical and binary data were presented using frequency tables and proportions.

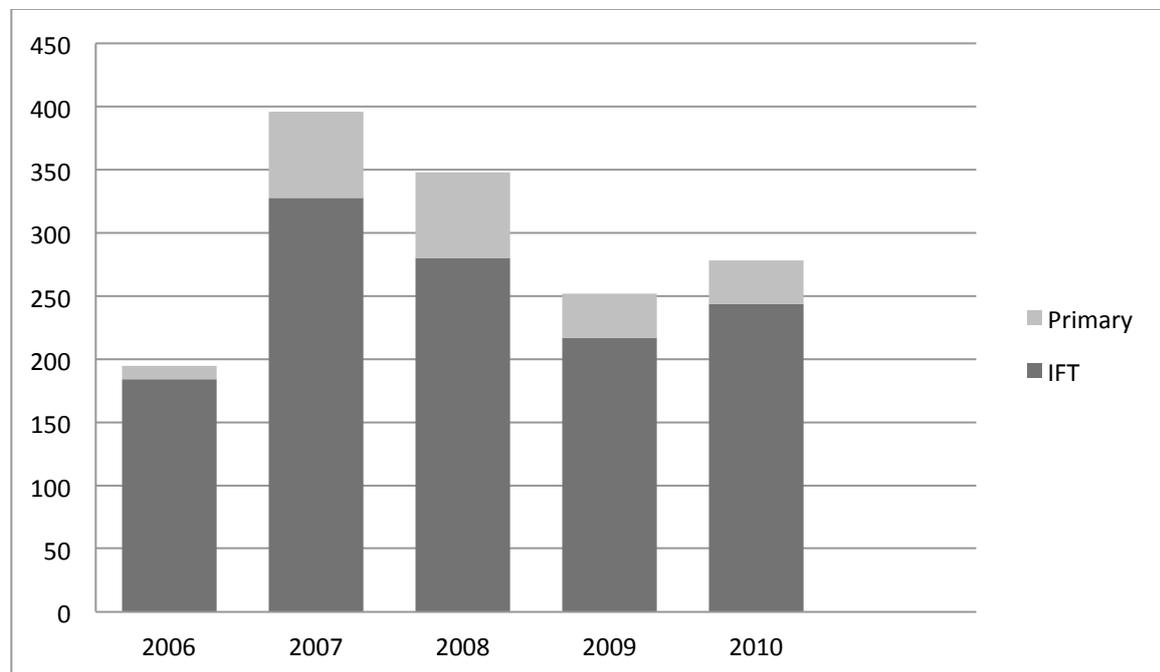
Inferential statistics were calculated using the Mann-Whitney U test when comparing continuous binary variables and the Kruskal-Wallis test for comparing continuous nominal variables. Bonferroni adjustments were done for multiple comparisons. A significance level of 95% was applied.

### RESULTS

A total of 1429 flights were undertaken during the five year study period. Three records were missing, leaving 1426 flights accessible for analysis.

#### Interfacility transfer vs. primary response

One-hundred-and-sixty-five (11.57%) flights were primary responses and 1253 (87.86%) interfacility transfers (Figure 1). Eight flights had incomplete data.



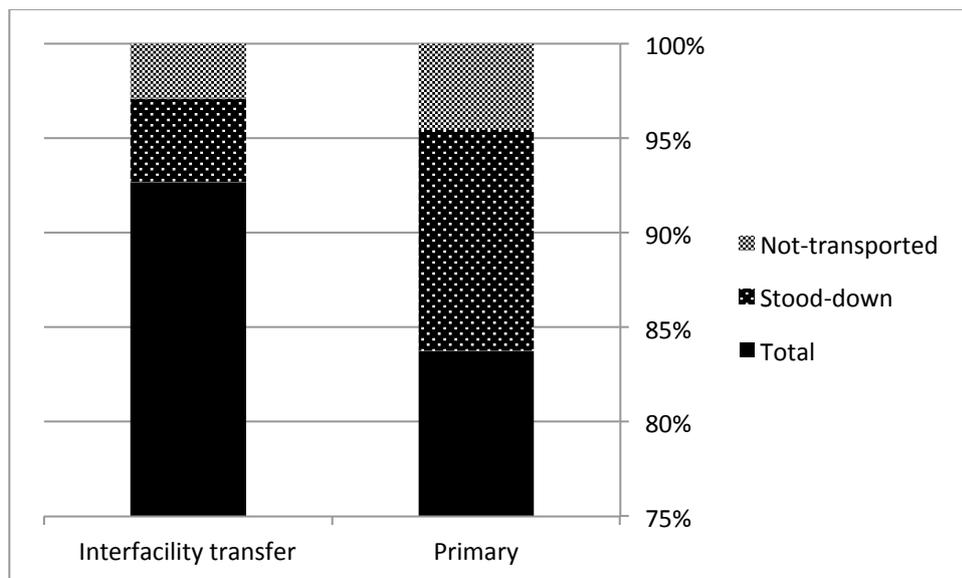
**Figure 1. Number of primary response and interfacility transfers per year**

IFT = Interfacility transfer

Primary = Primary response

### Stood-down and not-transported flights

One-thousand-two-hundred-and-eighty-seven flights transported patients (90.25%). Sixty-nine (4.84%) flights were stood down (IFT n=39, 3.11%; Primary n=23, 13.94%) and 70 (4.91%) flights didn't transport any patients (IFT n=60, 4.79%; Primary n=9, 5.46%). In eight flights it was unclear whether the flight was a primary or interfacility response. There were proportionally more stood-down and not-transported flights in the primary response group (Figure 2). Reasons for stood down flights were bad weather (n=39), patients already transported by other means (n=21), and other (n=9). Reasons for not-transported flights were patient died before loading (n=47), patient not fit for flight (n=15), and other (n=8).



**Figure2. Proportional representation of stood-down and not-transported flights in primary response and interfacility transfer**

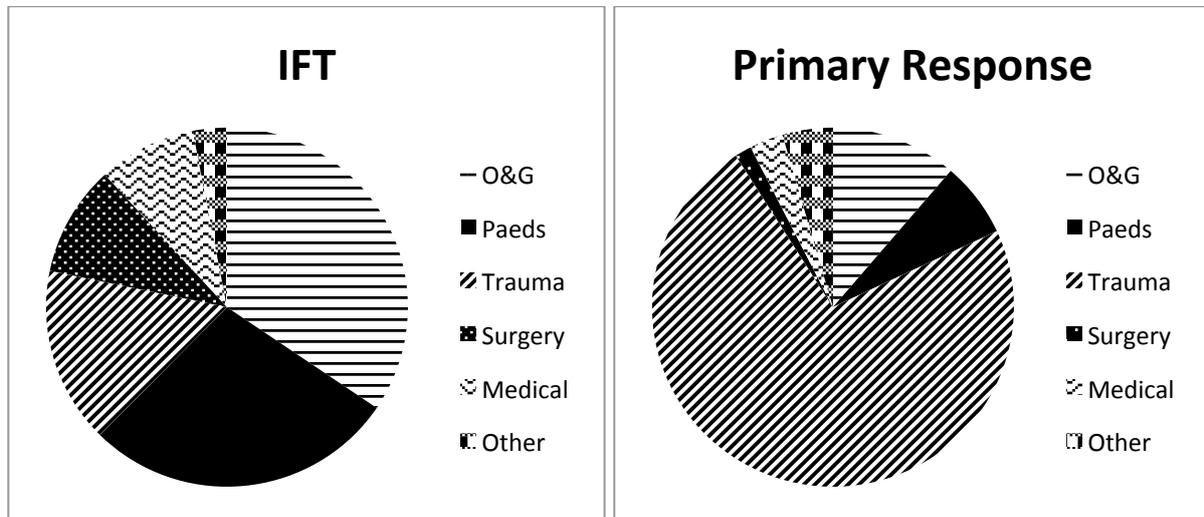
### Age of patients

In eighteen (1.4%) flights the age was not noted on the patient report form. The breakdown by age is: adult (n=797, 61.93%; IFT n=694, 60.14%; Primary n=103, 77.44%), paediatric (n=194, 15.07%; IFT n=172, 14.91%; Primary n=22, 16.54%), neonate (n=278, 21.6 %; IFT n=275, 21.95%; Primary n=3, 2.26%). Almost 19% (n=243) of the patients were less than 7 days old.

### Indications for flights

The indication for requesting the helicopter was predominantly obstetrics and gynaecology (n=413, 32.09%), paediatrics (n=331, 25.72%) and trauma (n=280, 21.76%) IFT had a high proportion of obstetric (n=398, 34.49%) and paediatric (n=322, 27.90%) indications for flight, with trauma (n=183, 15.86%) coming in third (Figure 3a). In primary response the primary indication was trauma (n=97,

72.93%), followed by obstetrics and gynaecology (n=15, 11.28%), and paediatrics (n=9, 6.78%), (figure 3b).



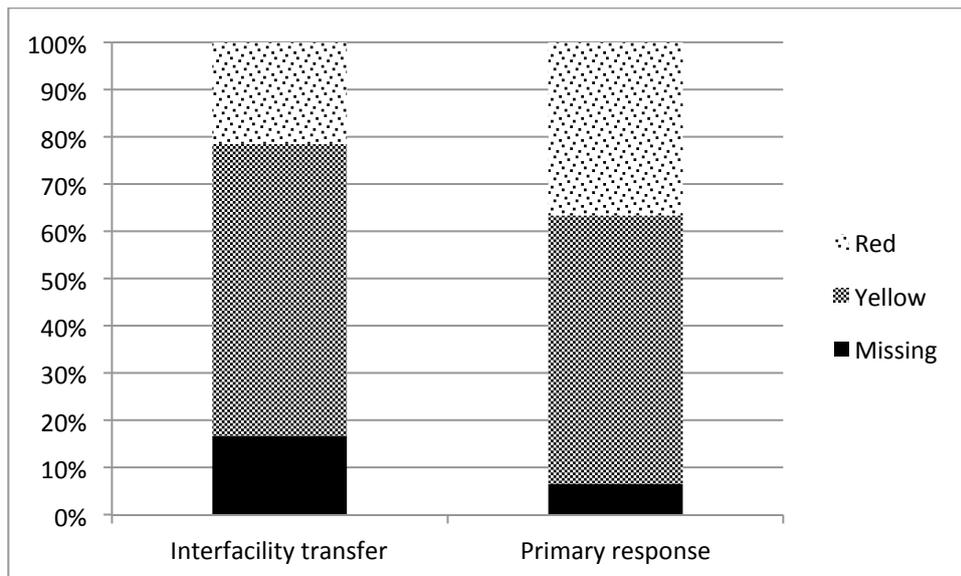
**Figure 3a and b. Indications for flights where patients were actually transported**

O&G: Obstetrics and Gynaecology

Other: poisoning, environmental conditions and snakebites

### Triage coding of flights

Triage was performed upon loading the patient onto the helicopter. Red codes comprised one fifth of the flights (n=291, 22.61%; IFT n=246, 21.32%; Primary n=45, 33.84%). Yellow codes were the most frequent (n=778, 54.56%; IFT n=708, 61.35%; Primary n=70, 52.63%). There were only nine (0.7%) green codes (IFT n=7, 0.6%; Primary n=2, 1.5%). One patient died during transport and was coded blue. There were 208 (14.59%) missing codes (IFT n=193, 16.72%; Primary n=15, 11.28%), (Figure 4).



**Figure4. Breakdown of triage codes of patients transported**

#### **Flight times**

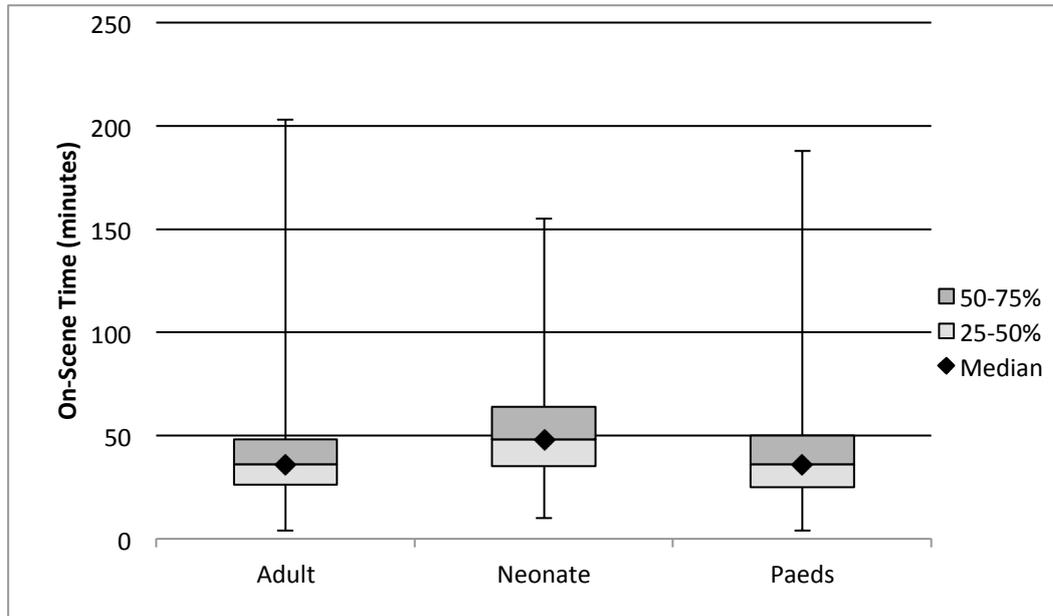
The median flight time from base to scene/hospital was 35 minutes for IFT (IQR 26-50), and 22 minutes for primary response (IQR 14.5-33.5). The flight times from scene/hospital to destination was 35 minutes in IFT (IQR 25-50) and 15 minutes in primary response (IQR 8-25).

#### **On-Scene times**

The overall median on-scene time was 39 minutes (IQR 27-51 minutes). The on-scene for primary response (23 minutes, IQR 13-32) times were shorter compared to inter-facility transfers (40 minutes, IQR 30-53).

There was no significant difference between adults (36 minutes, IQR 26-48 minutes) and paediatrics (36 minutes, IQR 25-51 minutes,  $p=1$ ). Neonates (48 minutes, IQR 35-64 minutes) were found to have much longer on scene times as compared to paediatric ( $p<0.02$ ) or adult ( $p<0.001$ ) patients (Figure 5). (There were not enough neonatal primary responses to compare primary response with IFT)

The presence of a doctor on board was associated with a statistically significant increased on-scene time (45 minutes, IQR 27-50) compared to flights without a doctor on board (38 minutes, IQR 27-57,  $p<0.001$ ). (There were not enough primary responses with a doctor on board to compare primary and IFT times separately)



**Figure 5 Boxplot by age group comparing on-scene times**

Note: The maximum adult on-scene time was 576 minutes due to an overnight stay. The second longest on-scene time has been used (203 minutes).

## DISCUSSION

This study showed an average of 285 flights per year over a five year period. In terms of absolute numbers this is similar to other rural HEMS (Japan 314 flights/year, Sweden 314 flights/year). (10,11) However, when one compares the number of flights per population served, there is a vast difference, with this service having 1 flight per 11930 people per year compared to 6622 people per year in Japan, 828 people per year for Sweden, and roughly 800 people per year in New Zealand. (10,11,12) There are quite a few possible explanations for our low flight request rate. Firstly, the EMS system in rural KZN has severe budget constraints and shortage of staff. (13) This results in prolonged response times by ground crew and severely injured poly-trauma patients may die before the need for the helicopter is realised (only 50% of rural response times for red coded patients by road were less than 40 minutes in 2009). (13) As it stood at the time of the study, the helicopter would only be activated once a road crew had reached the scene. Recent efforts subsequent to the study have been undertaken to facilitate earlier activation of HEMS. Secondly, many of the hospitals are staffed by unsupervised junior doctors who may under-estimate the patient's condition, thus not requesting HEMS. (14) Thirdly, many patients in this area prefer to seek help from traditional healers first and may present late in the course of disease such that referral would no longer be of benefit. (15) There is also an impression amongst doctors that the cost of HEMS is restrictive and they do not make use of it. This

reflects a lack of awareness of how HEMS is funded in the public service. The KZN Department of Health pays a fixed monthly cost which covers all fixed overheads of the HEMS service and funds for thirty flights per month. Any flights necessary over the thirty will only have fuel and aircraft maintenance costs as all the fixed overheads are covered by the monthly charge. With this funding model the cost per flight decreases the more the helicopter is used. The initial thirty hours of flight cost R22667 per hour while additional hours only cost R6008 per hour. When one compares this to the cost of running a ground ambulance which costs R25.51 per kilometre for ALS level of care, one can see that with greater distances the helicopter may be a cost effective means of transporting patients. (Personal communication Neil Gargan, General Manager South African Paramedic Services) This argument does not account for the fact that use of HEMS leaves the ground crew still present in the area to continue with local calls.

Primary response comprises 65% of other rural HEMS activations. (10,11) Our study reports a much lower rate (11.57%). As already mentioned, HEMS in KZN uses a two-tiered system whereby HEMS is only activated after EMS ground crew have arrived on scene and determined the need for HEMS. With ground response times of over 40 minutes in more than half of P1 cases in rural KZN there is a need for determining when HEMS should be activated primarily. (13) An algorithm to help decide on the need for HEMS should improve the appropriate use of HEMS in primary response. Algorithms have been designed to assist in deciding on the need for primary air transport in the UK. (8) The development of such an algorithm for an African setting is needed.

Stood-down rates of up to 35% have been shown in the UK, with other countries reporting stood-down rates between 8% and 17%. (10,11,16) The rate of stood-down and not-transported flights (9.75%) in this study is in the low-end when compared with other areas. However when one looks at the rates for primary response (19.4%) this is similar to other systems. Stood-down and not-transported flights add to costs without patient benefit. Situations such as poor weather cannot be avoided, and affect HEMS systems elsewhere. (16) However situations such as no receiving bed for the patient, or an aggressive or obese patient who is not fit for flight could be avoided.

Obstetrics and gynaecology, paediatrics, and trauma were the three most common indications for flight. This is similar to the New Zealand HEMS but different to that of Europe and Japan. (10,11,12) The New Zealand study attributed it to the reduction of maternal services in the region. Similarly, Northern KZN also has a shortage of maternal services. (13) Added to this is the effect of Africa's burden of disease. In African adults 15-59 years old, HIV/AIDS is the leading cause of death, followed by parasitic and infectious disease. (17) These are conditions which can generally be managed in peripheral centres and it is not surprising that they are not the main indications for flights in adults. In women, maternal and nutritional conditions are the third leading cause of death. (17)

Outcomes in maternal emergencies can be drastically altered by appropriate care from trained specialists and this explains the high number of obstetric and gynaecology flights.

Children, and particularly neonates, were transported in over a third of flights. This may be explained if one considers that children in Africa bear almost half the burden of disease. (17) Childhood deaths are mainly due to perinatal conditions, diarrhoeal diseases, respiratory disease and malaria. (17) Due to the staffing of district hospitals in Northern KZN by unsupervised junior doctors, management of critically ill children and neonates needs to be undertaken at a referral centre. (14) The area does not have a dedicated paediatric retrieval service, and so all paediatric flights are undertaken by HEMS. In other countries paediatric cases would be flown by a dedicated paediatric service. (18) Thus HEMS crew in KZN need to be adequately prepared to deal with the transport of critically ill paediatric patients.

Injuries are the third leading cause of death in African adult males. (17) Interpersonal violence accounts for most of the injuries in South Africa. (19) Road traffic accidents are also common with poor public transport and lawlessness on the roads being contributing factors. (19) Alcohol abuse contributes to both interpersonal violence and road traffic accidents. (19) As can be expected trauma was the primary indication for primary response.

It is likely that paediatrics, obstetrics and trauma may also represent the burden of any HEMS in the rest of rural Africa considering that the indications for flight are representative of Africa's burden of disease.

Our study found a lower incidence of red triage codes (22.61%) overall compared to other HEMS (54.3%). (10) Interpretation of this result is difficult because triage coding was not done in 14% of flights. Furthermore triage coding is done subjectively in KZN HEMS. A more objective triage scale such as the South African Triage Scale would make comparison with other services more meaningful. (20) This is important as HEMS cost-effectiveness improves with more seriously ill patients. (21) There is scope for further research into triage for HEMS in South Africa.

Flight times of 22 minutes to scene and 15 minutes from scene to hospital in primary response indicate that HEMS could play a much more vital role in primary response where the current response times to get to scene are over 40 minutes by ground crew in over 50% of priority 1 cases. (13)

Primary response by HEMS can also provide widespread advanced life support in a system which is severely short of ALS providers.

The prolonged on-scene time for neonates reflects the difficulties in transporting these patients. The median on-scene stabilisation time for neonates being transported by HEMS has been reported as 38 minutes. (22) This study shows a much longer median on-scene stabilisation time of 48 minutes. This longer time may be due to helicopter crew not being well prepared to deal with neonates, inadequate

equipment for neonates, or hospital staff not preparing neonates adequately for transport. It would be necessary to look into this in more detail in future studies. Although dedicated paediatric transport teams have shown improved outcomes and reduced incidence of adverse events, resources limit the ability to provide a dedicated paediatric transport service, either by road or air, in KZN. (23)

The optimal way to use physicians as part of HEMS crew has long been debated. Physicians can add benefit on-scene by performing advanced interventions, and through their decision-making capabilities (16). A randomised controlled study showed a 35% decreased mortality in physician-nurse staffed HEMS compared to paramedic-nurse staffed HEMS in blunt trauma. (24)

Staffing HEMS with a physician is more costly and physicians have been associated with longer on-scene times. (7) However, there is also evidence showing doctors to have no effect on on-scene times. (16,25) In our study the presence of doctors as part of the crew was associated with a longer on-scene time as compared to a paramedic only crew. This may be explained by the fact that the doctors are not dedicated to working on the helicopter, and are thus in an unfamiliar environment. This study did not look at specific reasons for longer on-scene times with physicians, nor was there enough data to look at primary response separately and further research is needed to determine whether the longer on-scene time affects outcomes, and whether physicians have longer on-scene times in primary response in this setting.

## **LIMITATIONS**

There was only one data collector and the data collection was not double checked by a separate party. This may have introduced bias in that the same error could have been repeated. The data was initially entered manually by the flight crew and any mistakes made at this point would be carried on into the study. No objective triage system was in place and so the assessment of triage category is subject to the bias of the particular crew working on the day. There was missing data in many of the categories. This may hide systematic bias.

## **CONCLUSION**

This study of rural African HEMS has shown a much lower flight per population ratio than other rural HEMS around the world. There is also a much lower incidence of primary responses. This may indicate that 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 differs from other rural HEMS, is representative of Africa's burden of disease, and may be expected to be the same in other rural African HEMS. 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 into HEMS in rural Africa, looking particularly at cost-benefit analyses, optimal activation criteria, and triage systems.

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## COMPETING INTERESTS

The authors declare that they have no competing interests.

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