

Emergency Obstetric Referral in Rural Sierra Leone: What Can Motorbike Ambulances Contribute? A Mixed-Methods Study

Sunil S. Bhopal · Stephen J. Halpin ·
Nancy Gerein

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Abstract Giving birth remains a dangerous endeavour for many of the world's women. Progress to improve this has been slow in sub-Saharan Africa. The second delay, where transport infrastructure is key in allowing a woman to reach care, has been a relatively neglected field of study. Six eRanger motorbike ambulances, specifically engineered for use on poor roads in resource-poor situations were provided in 2006 as part of an emergency referral system in rural Sierra Leone. The aim of this study was to evaluate the implementation of this referral system in terms of its use, acceptability and accessibility. Data were collected from usage records, and a series of semi-structured interviews and focus groups conducted to provide deeper understanding of the service. A total of 130 records of patients being transported to a health facility were found, 1/3 of which were for obstetric cases. The ambulance is being used regularly to transport patients to a health care facility. It is well known to the communities, is acceptable and accessible, and is valued by those it serves.

District-wide traditional birth attendant training and the sensitisation activities provided a foundation for the introduction of the ambulance service, creating a high level of awareness of the service and its importance, particularly for women in labour. Motorbike ambulances are suited to remote areas and can function on poor roads inaccessible to other vehicles.

Keywords Maternal mortality · Developing countries · Sierra Leone · Delivery of health care · Transport

Background

Giving birth remains dangerous for many of the world's women. Progress to reduce maternal mortality and morbidity has been slow in sub-Saharan Africa [1]. The main causes of maternal mortality in this region occur during labour, delivery and the initial 24 h postpartum period [2]. Evidence suggests that a “health-centre intrapartum-care strategy” [3], working as part of a functioning health system, is the best approach to encourage non-intervention for the majority of women whilst being prepared for detection and management of complications, including referral to higher level of obstetric care for those that need it.

The “three delays” model [4] (Fig. 1), conceptualises factors affecting appropriate use of maternal healthcare. Much emphasis has been placed on delay 3—regarding improved coverage and quality of emergency obstetric care. Tackling delay 1 involves initiatives to mobilise communities to use maternity services. The second delay (regarding transport infrastructure) has been a relatively neglected field of study.

In order to improve the proportion of women accessing care during pregnancy, the Kambia Appeal, a United

S. S. Bhopal
Newcastle Upon Tyne Hospitals NHS Foundation Trust,
Newcastle Upon Tyne, UK
e-mail: Sunil.bhopal@newcastle.ac.uk

S. S. Bhopal
Institute of Health & Society, Newcastle University,
Newcastle Upon Tyne NE1 7RU, UK

S. J. Halpin (✉)
Leeds Teaching Hospitals NHS Trust, St James's University
Hospital, Beckett Street, Leeds LS9 7TF, UK
e-mail: stephenjhalpin@googlemail.com

N. Gerein
Nepal Health Sector Support Programme, Ministry of Health,
Kathmandu, Nepal
e-mail: nancy@nhssp.org.np

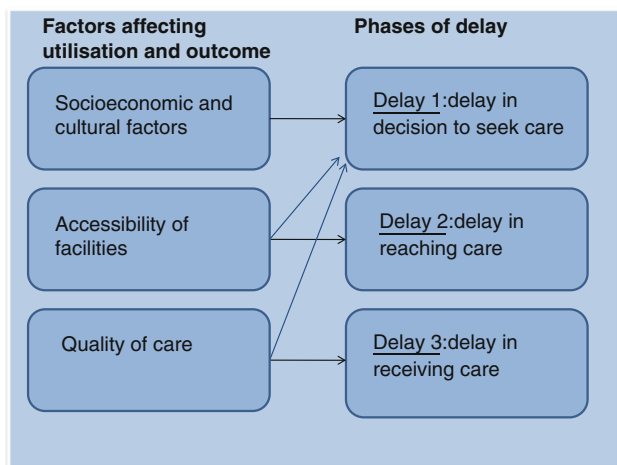


Fig. 1 The three delays model

Kingdom-registered charity, initiated a maternal health project in Kambia district, Sierra Leone. This includes (1) training for traditional birth attendants (TBAs) to bring women to health centres for delivery, (2) a motorbike ambulance system, (3) support for caesarean section at the district hospital, and (4) mass sensitisation to advertise all of the above.

Six eRanger motorbike ambulances, pictured in Fig. 2, specifically engineered for use on poor roads in resource-poor situations were provided in 2006 as part of an emergency referral system.

The focus was on women in labour, but they were also available for other emergencies in order to facilitate their acceptability within the community. The same ambulances have been used by health centres in Malawi, where they were found to reduce referral time and operating costs compared with jeep ambulances [5].

In this paper the initial phase of the ambulance service is analysed. The evaluation was carried out in September



Fig. 2 Volunteer driver sitting on motorbike ambulance with side car

2009, aiming to provide information on (1) the usage and acceptability of the ambulance, (2) awareness regarding the service, (3) the value placed on it, and (4) the applicability of the motorbike ambulance concept to other areas.

Study Setting

Sierra Leone has a population of 5.1 million. Kambia is a northern district (population 276,989) approximately 100 km by 50 km. The Kambia District Health Management Team (DHMT) oversees 52 peripheral health units (PHUs), each serving between 10 and 40 villages. These PHUs can refer upwards to the Kambia District Hospital, around 20 km away in Kambia town, the administrative capital.

This study focussed on the areas served by two PHUs. Barmoi PHU serves approximately 16,000 people, and is staffed by two nurses and two mother and child health aides. Maselleh PHU serves approximately 6,000 people, and is staffed by a nurse and an untrained health assistant. There are an estimated 11,000 births in the district each year, including 640 in Barmoi and 240 in Maselleh [6]. Geographically, the catchment area of Barmoi and Maselleh PHUs is a rugged environment poorly serviced by road infrastructure, with many rivers and streams which can become impassable in the rainy season, presenting a significant challenge in terms of emergency access to health care.

The motorbike ambulances were installed at Maselleh and Barmoi PHUs, and have been running for 22 and 14 months respectively. Ambulance drivers were trained by the Kambia Appeal and work as volunteers. When the ambulance is required, someone is sent by foot, bicycle or motorbike to the PHU where the PHU head summons a driver. The mechanism of an emergency referral in the motorbike ambulance is depicted in Fig. 3.

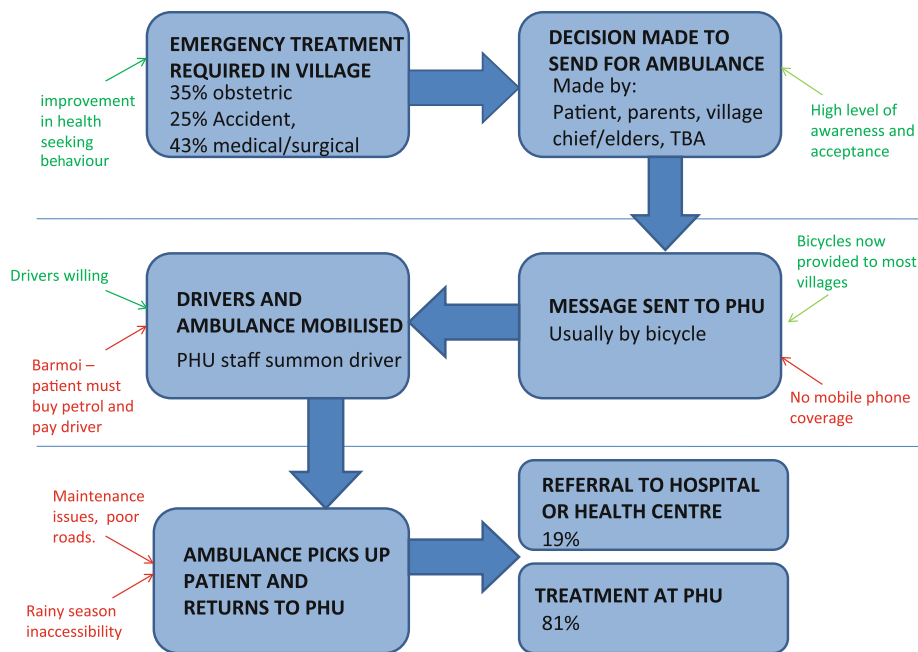
A community contribution system supports the scheme, whereby each household should contribute 500Le (\$0.12) per month. Collection is organised by the village chief, and the money is brought to the PHU.

In order to raise awareness of the ambulance service, a film—*Call Di Lifesaver* [7] demonstrating the purpose of the ambulance was produced and presented by a popular local entertainer. It was shown twice in each of the 69 villages over a 4 month period and viewed by over 18,000 people, more than half of whom were women. The film showings were accompanied by community meetings at which people were informed about the purpose of the ambulance, and could ask questions.

Methods

The PHUs keep records detailing each use of the ambulance, including data on date, patient identifying details,

Fig. 3 Stages of an emergency referral in the motorbike ambulance, Kambia, Sierra Leone. *Arrows* indicate the linear process by which a person is identified as needing treatment to arrival at a health facility. *Red and green arrows* suggest factors that constrain or encourage ambulance use (Color figure online)



start and end mileage, total mileage, reason for referral, treatment, outcome, and name of staff member. The records are collated quarterly at the Kambia Appeal offices in Kambia and UK. All four of these sources were used, in order to obtain as accurate a record of use as possible. When records were unclear, the investigators made a joint decision in coding, aiming to retain as much useful data as possible. Data regarding the community contribution system was gathered from the records held by the two PHU heads, which comprised handwritten tables of amount collected by village per month.

To obtain information on the acceptability and value of the service, 14 in-depth semi-structured interviews were carried out with heads of each PHU, staff members, ambulance drivers and ambulance users. They were conducted in English or with a Temne, Limba, or Krio translator. Past users of the ambulance service were selected for interview using a randomisation process. We identified all villages with more than three recorded users to increase the chance of finding past users able to provide an interview (as advised by local health workers), and randomly selected three such villages from each catchment area using the randomise function of Microsoft Excel (Microsoft Corp, California, 2010). On visiting these villages interviews were sought with the recorded past users in an order randomised by the same software. None declined. Through the use of this process we aimed to ensure participants were representative of the communities in which they live. Finally, one focus group discussion was held with six pregnant women in Maselleh who were identified by the head of that PHU in order to obtain insights from potential users.

All interviews were conducted over a 3 week period in September 2009 by two investigators, allowing for comparison of impressions after the interview. Reliability of findings was increased through triangulation, whereby emerging findings were tested by discussion with later participants, and with the managers of the project in Kambia. Qualitative findings from interviews were analysed using thematic analysis.

This evaluation was approved by the Kambia Appeal, and by the DHMT of Kambia district. Informed consent was obtained from all participants prior to interview.

Results

Use

A total of 130 records of patients being transported to a health facility were found, of which 74 were complete. Monthly usage was variable at both sites, ranging from 0 to 16 emergency journeys per month. Average monthly usage at Barmoi (6.2 uses per month) exceeded that at Maselleh (2.8 uses per month) reflecting Barmoi PHU’s larger catchment area. Interviews revealed that the ambulance was sometimes used for non-emergency reasons, including outreach, collecting medical supplies, purchasing fuel, and maintenance. All interviewees agreed that had the ambulance been called for, it would have been available. No satisfactory answer was found to account for the variability in call-out rates over the study period.

Recorded uses for patients with complete data are displayed in Table 1. Many obstetric patients were recorded

Table 1 Reasons for use of ambulance

Category	Reason for use	Frequency	
Obstetric	Labour pain	18	
	Obstetric (unspecified)	2	
	Obstructed/prolonged labour	3	
	Intrauterine death	1	
	Malpresentation (hand)	1	
	Antepartum haemorrhage	1	
Accident	Snakebite	6	
	Burns	2	
	Fallen from tree	2	
	Accident (unspecified)	1	
	Eye injury	1	
	Laceration	1	
	RTA (deep cut)	1	
	Septic wound	1	
	Testicular injury	1	
	Medical/surgical	Medical (unspecified)	9
		Hernia	6
Malaria		3	
Abdominal pain		3	
STI		3	
D&V		2	
PV bleed (unspecified)		2	
Back pain		1	
Food poisoning		1	
Haematemesis		1	
Polio (suspected)		1	

as having “Labour pain”, and it was unclear when this description referred to normal or problematic labour. However, given the difficulty for women and their carers to identify the difference, and the emphasis placed on health-centre based-care, this result is encouraging. There were a total of 26 obstetric referrals, amounting to around 2 % of estimated births in the two catchment areas during the period of the ambulance’s operation. Other reasons for referral may appear to be non-emergencies (e.g. hernia), however interviews suggested there is no problem with inappropriate referral, that these patients had severe symptoms requiring health centre input. Two-thirds of emergency patients were women.

Around one-third of all emergency referrals were for obstetric cases, with accidents comprising around a fifth (Fig. 4).

Eighty-one percent of emergency referrals were from the village to the PHU, while the rest were to access higher levels of care.

The catchment area for the service began as 69 villages, reducing over time to 59 villages. Patients were collected from 48 villages and 18 other unidentifiable locations,

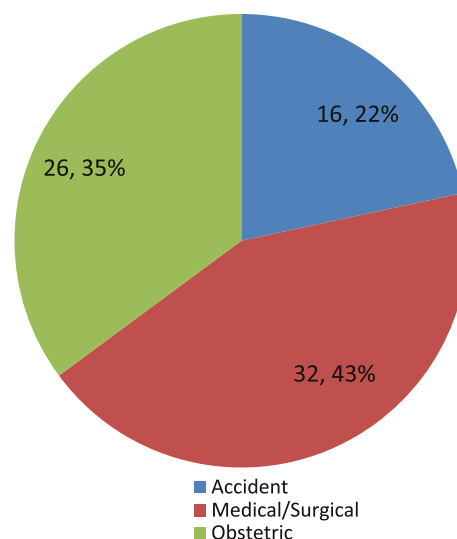


Fig. 4 Broad reason for use of ambulance

indicating that most villages were both accessible to the ambulance and used it at least once. However, access to the service was not possible for a few villages due to stone and dirt tracks that are sometimes too narrow for even the motorbike ambulance. This situation worsened during the rainy season, and led to a few occasions when requests for the ambulance were denied. This had important consequences, including the ambulance never being called again:

The ambulance came here once and collected a sick person. But the next time we sent for it the person [at the PHU] said that he would not release it because the road is too bad. That woman died. We have needed it since, but are afraid that the doctor would repeat the same statement, so if someone gets ill we carry them in a pot. [Village chief, Barmoi catchment]

There was no evidence that people within villages were excluded from use of the ambulance due to wealth, social status, education or other factors. The ambulance was well accepted; no evidence was found of people not wanting to use the ambulance.

PHU staff do not operate a triage system based on the messenger’s report of the medical condition. If the ambulance is available and the village accessible, then the ambulance is sent. Factors identified by thematic analysis which act to facilitate or impede ambulance use are indicated by the small red and green arrows in Fig. 3.

Awareness

All interviewees had heard of the ambulance, and knew its purpose. No incorrect perceptions regarding its purpose were found. Village residents indicated that all members of the community are aware of the ambulance, because of the

community meetings and the film, and by seeing the ambulance in use:

[I heard about it] from my friends, and the message went round the village from the chief. Also I saw it in action, going through the village helping other people. [Past user 1, Maselleh catchment]

I heard about it from the MCH aide at Maselleh. I went to a community meeting, and so I knew all about the ambulance before using it. [Past user 5, Maselleh catchment]

Yes everybody here knows about the ambulance. This is because they brought a film here all about the ambulance and they told us all about it. The whole village gathered together to watch this film. [Past user 1, Barmoi catchment]

This wide level of awareness indicates the success of the sensitisation activities. There were no reports of lack of awareness leading to delays or non-use.

Health Improvement

This data cannot demonstrate with numerical indicators the health benefit of the service. However, at least 130 emergency patients have been taken to a health facility, with about one-third of use being for women in labour. In the majority of these cases, records are not specific enough to infer the morbidity or mortality avoided by these obstetric referrals. However, in the 6 cases of obstructed or prolonged labour, antepartum haemorrhage, hand presentation and intrauterine death, it is reasonable to suggest that significant morbidity or mortality was averted. Similar reasoning can be applied to non-obstetric cases such as snake bite and burns. The inference of a significant health benefit is supported by the opinions of health staff, users and community members.

Perceived Value

Staff believed that the ambulance has improved the ability of the healthcare system to deal with patients, particularly emergency cases:

The main benefit is the reduction in the maternal mortality rate that has happened here. Before the ambulance arrived, they used to keep the women in labour in the village until the last minute. By the time they brought the patient it would be too late for the patient to survive. Since the ambulance came that has been minimised. [Head, Barmoi PHU]

The ambulance is very important. I love the ambulance. For example, last month a pregnant woman

from Buruliah had a low blood pressure and was not breathing. The ambulance brought her to the PHU, I referred her to the hospital and the woman's life was saved. [Head, Maselleh PHU]

Community members and past users of the ambulance were quick to point out that the ambulance is saving lives, and that they value the service greatly:

If it wasn't for the ambulance people would have died, but as it is they have their lives. We're all really glad it's there. [Past User 7, Maselleh catchment]

If the ambulance was not here, and a woman had pregnancy problems and did not have money, she would lose her life. [Antenatal focus group, Maselleh catchment]

Furthermore, the ambulance is perceived to be preferable to older transport methods which include being carried in a hammock or cooking pot. On motorable roads it is possible to charter passing private vehicles, but this is expensive and would result in delays.

Financial Contribution

Records kept on the contributions were inadequate for full analysis; however a complete set of data was available for a 4 month period in 2008 at one PHU, covering 29 villages. A total of 595,000Le was collected, which was 56 % of the expected amount required to cover running costs. Recovery of the 500Le/month/house was irregular; 52 % of all villages contributed some amount each month, and only 38 % contributed the same amount each month. However, only 3 villages contributed nothing over the 4 month period for which data were available.

Discussion

The findings indicate that the motorbike ambulance service is being used regularly to transport patients to a health care facility. It is well known to the communities, is acceptable and accessible, and is valued by those it serves. District-wide TBA training and the sensitisation activities provided a foundation for the introduction of the ambulance service, creating a high level of awareness of the service and its importance, particularly for women in labour. Without such a comprehensive effort it can be assumed that usage of the service would have been lower.

There were no records of timings for referrals using the ambulance, and they could not be estimated from interviews. It is reasonable to suggest that using the motorbike is faster than the alternatives of being carried or using a

jeep ambulance, because jeeps are stored centrally far from the villages, and cannot be driven on many dirt roads.

The ambulances cost approximately £3,000 each. As an indication of running costs, it was found that over 2 months each site spent approximately 350,000Le¹ on fuel and maintenance. This equates to 2,100,000Le per site per year, or about £350. A system of community contributions was introduced to encourage a sense of community ownership and movement towards financial sustainability. Although the amount of money yielded has been about half the expected contribution, there is a stated willingness to pay within the community. Both village chiefs and community members support the system in principle and prefer it to larger payments at the point of use. An ideal scheme would offer local ownership and sustainability, including contributions from the DHMT budget, with minimal external input. The current inconsistency in payments indicate the scheme needs improvement to maintain credibility, however the considerable potential benefits and existing base of support suggest it should be pursued further.

Small maintenance problems such as punctures are repaired at the village level. Problems with the wheel spokes were repaired by a mechanic employed by the Kambia Appeal who had to travel from the main town. Problems with the front wheel forks required parts from South Africa imported via the UK. This process took months. eRanger have since improved the design to avoid similar dysfunction in future. The aim for the new model is to be fixable at the local level using easily available and inexpensive parts.

Record keeping was difficult. In particular, most recorded mileages were meaningless and could not be analysed. Mileage figures could provide accountability regarding usage, however mileage has not been recorded accurately, even with specific training given to staff and drivers. Some patient journeys were recorded in three separate locations, and had conflicting information. Despite these limitations, record keeping was taken seriously by staff. There is no indication that journeys go unrecorded. An improved template sheet, provided in adequate quantities, alongside explanation regarding the purpose of data recording, may improve data collection efforts.

This study aimed to provide initial insights into an important health intervention. Results should be read bearing in mind that interviewers were likely to be associated with the donor organisation, creating a possible bias in responses. Furthermore, translation always presents difficulties and was conducted by local people rather than experienced professionals.

Conclusion

A system of emergency referral using specially designed motorbike ambulances was well known and valued by rural communities. Motorbike ambulances are particularly suited to remote areas and can function on poor roads inaccessible to other vehicles. The capital and ongoing costs of a motorbike ambulance are low, and implementation of such a system is possible in a short time. Storing the ambulances in the periphery—at Peripheral Health Units—rather than at the district hospital has been shown to work, keeping them close to the areas in which they are needed and not leading to inappropriate use.

Whilst the causes of maternal mortality and morbidity are known, the factors surrounding their improvement remain complex. However, it appears that a motorbike ambulance provided at low cost as part of the healthcare system in rural areas can help to reduce a key barrier to receiving care. Further research is required to quantify this improvement, and to identify generalisable features of the system.

Conflict of interest The authors declare they have no conflict of interest.

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¹ £59 at contemporaneous (2009) rate of exchange, 6,000Le = £1.