

# Ambulance service within a comprehensive intervention for reproductive health in remote settings: a cost-effective intervention

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## Summary

**OBJECTIVE** To assess the cost-effectiveness of an ambulance service within a comprehensive hospital/community-based program aimed at improving access and quality of reproductive health in poor-resources settings.

**METHODS** Obstetrical cases referred to the hospital with the ambulance during a 3-month period were prospectively recorded. Clinical indications were used to determine the effectiveness of the referral; the direct costs of the service were calculated. Overall effectiveness was then measured against WHO thresholds.

**RESULTS** Ninety-two obstetrical referrals were recorded. Eleven (12%) were considered effective, corresponding to 611.7 years saved. Cost per year saved was 15.82 US dollars which about half of WHO's 30 US dollar benchmark defining very attractive interventions. Sensitivity analyses on the costs of the ambulance and the rate of effective referrals emphasized the robustness of the result.

**CONCLUSIONS** The cost-effectiveness profile of an ambulance service within a series of interventions aimed at improving reproductive health in remote settings is very attractive.

**keywords** ambulance, remote settings, cost-effectiveness, reproductive health

## Introduction

An integrated and comprehensive hospital/community based health program is recommended to reduce maternal and child mortality and morbidity in poor-resources settings (World Health Organization 2005; Murray & Pearson 2006; Kongnyuy *et al.* 2008; Evjen-Olsen *et al.* 2009; Parkhurst & Sengooba 2009). This kind of program includes the availability of reproductive and child health services, HIV/AIDS treatment and prevention (including vertical transmission), comprehensive emergency obstetric care, ambulance, health promotion radio messages, paediatric care and a generalized healthcare.

Among facilities aimed at fulfilling the goal of improving access to and quality of reproductive health, the ambulance service plays an important role, especially in remote settings (Shehu *et al.* 1997; Murray & Pearson 2006; Hofman *et al.* 2008; Kongnyuy *et al.* 2008; Evjen-Olsen *et al.* 2009; Parkhurst & Sengooba 2009). An ambulance

service fosters the creation of a network linking the different Health Centers and allows the referral of urgent and complicated cases. However, the costs of such a facility are high, especially for a poor setting; thus one has to wonder about its overall effectiveness. Generally, the ambulance services are initially supported and implemented by non-governmental organization (NGO)-related programs but once the programs end, maintaining the service falls to the local health system. This highlights not only the importance of its cost-effectiveness but also affordability. Proper allocation of the scarce resources in remote settings is an utmost concern (World Health Organization 1996). Inappropriate allocation may result in a significant number of lives lost.

Hence, there is the urgent need to clarify the effectiveness of an ambulance service in programs aimed at improving access and quality of reproductive health. Surprisingly, this aspect has received poor attention in the past (Krasovec 2004). Even if some economical analyses

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have documented that comprehensive interventions to improve reproductive health are cost-effective (Borghi *et al.* 2005; Goldie *et al.* 2010; Nizalova & Vyshnya 2010), few and incomplete studies specifically investigated the economical profile of the ambulance service itself (Hofman *et al.* 2008). This is an important point, since implementation and maintenance of this service is expensive and local authorities may have concerns regarding its sustainability.

Our aim was to perform a cost-effectiveness analysis on the use of an ambulance within a hospital/community based reproductive health service. The recent implementation of a project to improve the access to and quality of reproductive health in Oyam District in northern Uganda gave us the opportunity to prospectively collect data on the costs and effectiveness of such a facility.

## Materials and methods

### Setting and project

The annual GDP of Uganda is about 490 USD per capita (UBOS 2009). The Ministry of Health has a leadership and financing role, service provision is delegated to the health district. In general, services for normal (uncomplicated) deliveries are offered at Health Centres (HC) II and III serving up to a sub-county, while complicated cases are usually referred upwards to Health Centres IV, serving the sub-district, or district hospital.

Oyam District in northern Uganda was recently established in 2006; the area has been strongly affected by the civil war, thus remaining one of the more disadvantaged districts in the country. It has an estimated population of 329,600 people and 15,988 expected deliveries per year. The rate of deliveries conducted in health facilities is estimated to be 26% (Birungi *et al.* 2009). Oyam district has one hospital (John's Pope Hospital, Private non for profit, Aber) ensuring about 1600 deliveries per year with a caesarean section rate during the study period of about 20%. The district health system included 23 Health Centres (17 HC II, 5 HC III and 1 HC IV). Caesarean section is provided only at the hospital. The distance from the hospital to the Health Centres varies from 7 to 80 km (median: 38 km). Connecting roads are mainly rough. Since March 2008, a referral system from the peripheral Health Centres to the Hospital has been in place.

The ambulance was located within the hospital and referrals were exclusively directed to the hospital. Time to referral substantially varied with distance and weather conditions (from 30 min to 3 h). The service is assured for 24 h by three drivers and a single vehicle. In case of

breakdown or car maintenance, a substitute normal car is temporarily used (this generally occurred about one-two days per month). The main function of this second car (Toyota Land Cruiser 75/78) was to supply administration services to the hospital. Even if not specifically equipped as an ambulance, it was deemed effective for non-traumatic referrals such as those generally necessary for reproductive health. An internal rule strongly forbid the use of the ambulance for non-medical services. Drivers not respecting this rule could be fired. Health Centres were provided with mobile phones to contact the hospital, where the ambulance is based; communication costs were covered by the project. The service is essentially directed at maternal cases and free of charge. It is part of a European Union funded project entitled '*Improving access and quality to Reproductive Health in Oyam District, Uganda*' (Europe-Aid/123767/C/ACT/Multi) and implemented by an Italian NGO (Doctors with Africa CUAMM). This was a 3-year comprehensive and integrated project, starting on 1 October 2007, whose overall objective was the achievement of maternal and neonatal morbidity and mortality reduction. The main activities also included strengthening of the referral system through staff trainings and supervision of the Health Centers.

### Data collection

From 1 December 2009 to 28 February 2010, all referred cases were evaluated and managed by the two medical doctors allocated to the maternity ward, both experienced obstetricians (E.S. and E.O.). Data regarding the cases were collected prospectively in a standardized way. Recorded items included clinical characteristics at referral, clinical course and pregnancy-neonatal outcome. Both doctors were separately requested to judge the effectiveness of referral by classifying cases into three categories: (1) *Not effective* when the referral with the ambulance was thought not to impact on the outcome; (2) *Possibly effective* when the referral has modified the outcome but it cannot be excluded that referral by other means (such as asking for lifts by bicycle, motorcycle or truck) would have been equally effective; (3) *Undoubtedly effective* when the referral modified the outcome and referral by other means was thought to negatively impact on the outcome. Judgments were given separately for the mother and the infant. These effective categories were based on the clinician's judgment. They were predefined but the definition was not strict allowing to adapt the decision to the specific clinical conditions. Judgments had to be given within 24–48 h of the event. A third physician (R.N.) could be involved in case of controversies between the two doctors (this however was never necessary).

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Referrals of cases managed in the hospital by the use of simple procedures (such as oxytocin administration, amniotomy or manual removal of the placenta) were considered not effective as the same management could be provided in the Health Centres. During the study period, some women used private transports for referral. These women were not included in the analysis. The women and their newborns were discharged only if in good condition. Life expectancy was considered similar to the general population in these cases. Referrals resulting in newborn or maternal death after birth but during the hospital stay were conversely considered ineffective. Life expectancy was not adapted to the specific health conditions (such as for instance caesarean section or prematurity).

The study was approved by the local institutional review board. The patients (or the relatives in case of death) gave informed consent to participate.

#### Cost-effectiveness analyses

The perspective of the analysis was the one of the District Health provider. The ultimate aim of the paper was to provide a tool to help local authorities making health choices. All costs falling on the district health system were thus included. They were those of the ambulance service itself and those related to the assistance in the hospital. Costs for staff training and Health Centers supervisions were not included because these activities were already in place and the inclusion of the item of the ambulance did not affect the costs.

Costs of the ambulance service included: the cost of the ambulance itself (costs calculated based on an estimated four years use of the car), personnel, fuel, insurance, maintenance and mobile phone expenses. In order to temper possible important variations of the costs of maintenance, this item was calculated as 25% (3 out of 12 months) of the total expenses recorded over the last year of use. Fuel costs for uncommon but possible non-obstetrical referrals were excluded (based on kilometres covered as recorded in the log-sheets and the mean consumption per kilometre).

Costs of the health assistance in the hospital included additional costs related to the hospital referral. In other words, we included costs that were different from those related to the assistance that would have been offered in the Health Centers. They mainly include surgical procedures (caesarean section and evacuation), second-line uterotonic agents, fluids and parental antibiotics. In contrast, costs of blood transfusions were not included since in Uganda they are entirely supported by the Minister of Health. Moreover, costs for cases whose assistance was similar to the one that would have been offered in the

Health Centers (i.e. unremarkable spontaneous vaginal delivery) were not included. Personnel costs were also excluded since 24-h assistance was already available prior to the implementation of the project and, until now, the impact of the ambulance service did not determine the need for increasing the duty personnel. Costs were calculated based on the local drug provider (JMS-Joint Medical Store, <http://www.jms.co.ug>). A mean cost was calculated for the two most common procedures. They were as follows: 40.77 US dollars for caesarean section (sutures, surgical blades, antibiotics, anaesthetic drugs, fluids, pain-killers, disinfectant agents, syringes, needles, administration sets, gauzes, plaster, urine catheters and bags, surgical gloves, blood analyses and fuel for generator) and 7.11 US dollars for evacuation (antibiotics, anaesthetic drugs, fluids, pain-killers, disinfectant agents, syringes, needles, administration sets, gauzes, surgical gloves and fuel for generator). These costs referred to uncomplicated procedures. For complicated cases or for less common cases, costs were specifically calculated for each case consulting the patients' charts.

The benefits were estimated on the number of years saved calculated for each patient (mother and child) based on the local life-expectancy tables (WHO Statistical Information System 2006). A 3% discount of the life years gained was applied and a sensitivity analysis increasing this rate up to 6% was done (Drummond *et al.* 2005). Prevention of disabilities was not included in the model. The benefits of non-obstetrical referrals were also excluded. The main analysis focused entirely on cases classified as 'undoubtedly effective'. A secondary analysis was repeated considering effective also those cases classified as 'possibly effective'.

Three reference values for cost-effectiveness of the ambulance service were considered. The intervention was deemed acceptable if the costs per each year saved would be below the Gross Domestic Product (GDP) per person per year in the country (490 US dollars) (Uganda Bureau of Statistics 2009), attractive if <150 US dollars and very attractive if <30 US dollars (World Health Organization 1996). Sensitivity analyses were carried out for the costs of the ambulance and for the proportion of effective cases. We evaluated the impact of a theoretical variation of these variables on the effectiveness of the intervention and drew a figure to illustrate the results.

#### Results

Ninety-two obstetrical referrals were recorded. The baseline characteristics of the patients are shown in Table 1. The clinical conditions at referral and the outcome of the cases considered effective are summarized in Table 2.

E. Somigliana *et al.* **Ambulance service for reproductive health in remote settings****Table 1** Baseline characteristics of the cohort of referred cases (*n* = 92)

Characteristics	Mean ± SD or <i>n</i> (%)
Age (years)	24.4 ± 6.8
Number of previous deliveries	
0	32 (35)
1	11 (12)
2	6 (6)
3	8 (9)
4	13 (14)
≥5	22 (24)
Gestational age (weeks)	
<28	14 (15)
28–36	19 (21)
≥37	59 (64)

Overall, the referral was scored as undoubtedly effective in 11 cases (12%). Specifically, 10 mothers and 5 children mainly benefited from the service. When considering together the possibly and undoubtedly effective referrals, the number increased to 30 cases, corresponding to 33% (29 mothers and 21 infants). Cases were judged as not effective for both the mother and the newborn in 62 referrals (Table 3). The ambulance covered 7,699 km for obstetrical referrals and maintenance. The costs of the ambulance service are shown in Table 4. The total expense was 7,853 US dollars for the 3 months. The additional costs related to the hospital referral were 1,822 US dollars, with caesarean sections being the most relevant item (1,641 US dollars corresponding to 90%). The overall costs of the ambulance service were thus estimated to be 9,675 US dollars (7,853 + 1,822).

**Table 3** List of referred cases judged as not effective for both the mother and the newborn

Clinical conditions	<i>n</i>
Obstructive labour, SVD, baby alive	26
Spontaneous abortion, not severe bleeding	9
Obstructive labour, delayed CS, baby alive	7
Antepartum mild vaginal bleeding, no emergency treatments	4
SVD, baby dead	4
PPH, non-severe bleeding	2
Threatened abortion	2
Severe malaria	2
Maternal death due to DIC of unknown origin	1
SVD in HIV-infected woman	1
Labour in women with previous VVF repair (CS)	1
Urinary tract infection in pregnancy	1
Retained placenta, manual removal, non severe bleeding	1
Abdominal trauma without consequences	1

SVD, spontaneous vaginal delivery; PPH, post-partum haemorrhage; DIC, disseminated intravascular coagulation; VVF, vesicovaginal fistula; CS, caesarean section.

When the analysis exclusively focussed on undoubtedly effective cases, we calculated 630.6 years saved. Applying the standard discount of the life years gained of 3%, the total number of years saved become 611.7. The cost per year saved was thus 15.82 US dollars. This result is below all the 3 cut-off values stated (490, 150 and 30 US dollars), thus classifying the intervention as very attractive from a cost-effectiveness perspective.

The sensitivity analysis modifying the costs of the ambulance is shown in Figure 1. The intervention remains extremely effective varying this variable. The

Clinical conditions	Mother number	Newborns number
Undoubtedly effective		
Uterine rupture, immediate CS, fetal death	5	0
Uterine rupture, immediate CS, fetus alive	2	2
PPH, severe anemia, immediate blood transfusion	2	0
Eclampsia, maternal support, CS (twin pregnancy)	1	2
Transversal lie and fetal distress, immediate CS	0	1
Total	10	5
Possibly effective		
Obstructive labour, immediate CS, baby alive	15	15
Obstructive labour, immediate CS, baby dead	2	0
Severe preclampsia, maternal support, CS	1	1
Retained placenta, mild bleeding, placenta accreta, hysterectomy	1	0
Total	19	16

**Table 2** Clinical findings of effectively referred patients

Effectiveness in the mother and the newborn did not always correspond. CS, caesarean section; PPH, post-partum haemorrhage.

**Table 4** Costs of the ambulance

Expenses	Costs per unit	Costs for the study period (3 months)	Extrapolated costs per year
Car (Toyota Land Cruiser 75/78)*	51,305	3,207	12,826
Car insurance	1,731 (per year)	433	1,732
Adjunctive driver insurance	137 (per year)	34	136
Referral system <sup>†</sup>			
Mobile phones <sup>‡</sup>	263	22	88
Sim cards <sup>‡</sup>	35	3	12
Air-time	164 (per year)	41	164
Fuel		1,670	6,680
Car maintenance <sup>§</sup>			
Service	3,420 (per year)	855	3,420
Damages Repairal	1,760 (per year)	440	1,760
Tyre repairal – substitution	1,056 (per year)	264	1,056
Drivers gross salaries ( <i>n</i> = 3)	1,179 (per year)	884	3,536
Total	n.a.	7,853	31,412

Costs are expressed in US Dollars.

Costs used in the analysis are those reported in the third column. To facilitate awareness of the costs, extrapolation on a one year period was added in the last column.

\*Calculation done based on an hypothesized 4 years duration and included an interest rate of 6% per year (<http://www.bou.or.ug/bouwebsite/opencms/bou/home.html>).

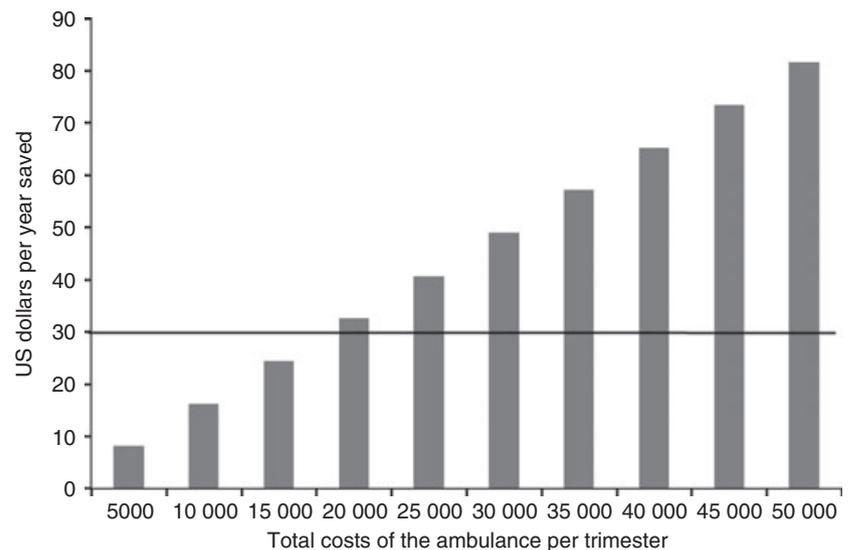
†Mobile phones were provided to the Health Centers III, IV and the hospital (*n* = 7). Sim cards and airtime were provided to all the facilities, including the Health Centers II (*n* = 24).

‡Calculation done based on an hypothesized 3 years duration and included an interest rate of 6% per year (<http://www.bou.or.ug/bouwebsite/opencms/bou/home.html>).

§Calculation done as the 25% of the last year period.

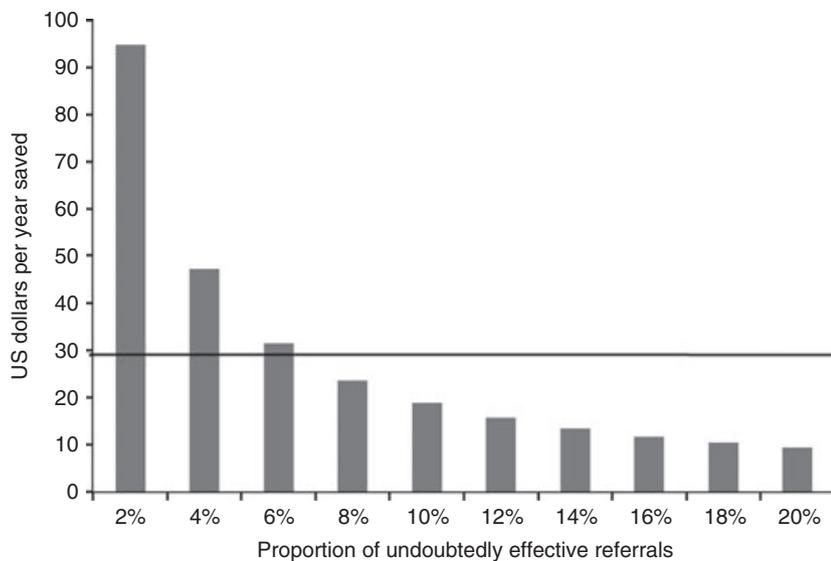
n.a.: not applicable

**Figure 1** Sensitivity analysis according to the cost of the ambulance. The cost-effectiveness remains excellent until the ambulance costs reach 18,351 US dollars (corresponding to the cut-off of 30 US dollars per year saved). Thereafter, it remains attractive since it is far below the cut-off value of 150 US dollars. Costs refer to a 3-month period.



cost-effectiveness is very attractive until the ambulance costs reach 18,351 US dollars (corresponding to the cut-off of 30 US dollars per year saved). It is then attractive

until costs rise to 91,755 US dollars (corresponding to the cut-off of 150 US dollars per year saved) and it remains effective until the costs reach 299,733 US dollars



**Figure 2** Sensitivity analysis according to the proportion of undoubtedly effective referrals. The cost-effectiveness remains excellent until the rate reaches 6.3% (corresponding to the cut-off of 30 US dollars per year saved). It remains attractive until it reaches 1.3% (corresponding to the cut-off of 150 US dollars per year saved).

(corresponding to the cut-off of the GDP pro capita of 490 US dollars). Considering separately the three main items of the ambulance costs, i.e. the car (initial costs of the car itself, insurances and maintenance), the fuel and the drivers' salaries, the intervention remains very attractive until a raise of these three points of 201%, 629% and 1188%, respectively. As expected, these results become more striking when benchmarks for attractive or effective interventions are used (data not shown).

The sensitivity analysis modifying the proportion of undoubtedly effective cases is shown in Figure 2. The cost-effectiveness remains very attractive until the rate reaches 6.3% (corresponding to the cut-off of 30 US dollars per year saved) and is attractive until it reaches 1.3% (corresponding to the cut-off of 150 US dollars per year saved). It is then still effective until the rate decreases to 0.4% (corresponding to the cut-off of the GDP pro capita of 490 US dollars).

Increasing the discount of the life years gained from 3% to 6% did not markedly modify the scenario. The number of years saved become 592.8 and the cost per year saved turned into 16.32 US dollars, still below the benchmark to define the intervention as very attractive. The intervention remains very attractive (30 US dollars per year saved), attractive (150 US dollars per year saved) and effective (490 US dollars per year saved) up to a discount of life years of 49%, 90% and 97%, respectively.

Finally, all the analyses were repeated considering together the possibly and undoubtedly effective referrals. As expected, the intervention resulted even more effective. We calculated 2,212.5 years (including the discount of

life years saved of 3%). The cost per year saved was 4.37 US dollars.

## Discussion

In this study, we documented that, within the framework of reproductive health in remote setting, an ambulance service is highly cost-effective. The cost per year saved was 15.82 US dollars; far less than the benchmark for a very attractive cost-effective intervention – 30 US dollars per year saved (World Health Organization 1996; Lubell *et al.* 2008). The sensitivity analyses for the ambulance costs and for the rate of undoubtedly effective cases emphasize the robustness of this conclusion. The model is poorly influenced by the ambulance costs and remains attractive until a 10-fold increase in costs. Similarly, the intervention remains attractive until a 10-fold lower rate of critical referral. In fact, it is effective up to a rate of 1.3%. In other words, it is cost-effective until a situation of 77 'useless' referrals for one critical case.

Some strengths and limitations of the study should be considered. As for the firsts, it is noteworthy that this is a prospective study. Erroneous recording of the data is thus unlikely. Furthermore, all cases were reviewed by a team of expert obstetricians, thus reducing the risk of misclassification of cases. The main limitation is that the assumption regarding effectiveness of the intervention remains theoretical. There is no way to consistently determine whether referral by other means would have actually led to the demise of the mother or the foetus. An enlarged study actively involving all the Health Centres would have allowed to improve the accuracy of this

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estimate. In particular, a rigid categorization of the near miss or severe complications (World Health Organization 2005) before referral would have provided some more reliable information. Unfortunately, the quality of the health staff in the district did not allow us to design this kind of study.

Another debatable point may be the decision to apply Ugandan life expectancy-tables without adjusting for region and pathologies. It may indeed be argued that life expectancy may be lower in Oyam District and that the application of these tables to all the clinical conditions (such as for instance prematurity or caesarean section) may lead to an overestimate of the benefits. But specific life expectancy-tables for Oyam district are not available and that women and their newborns were discharged only if well. Referrals dying before discharging were considered ineffective. Furthermore, the sensitivity analysis on this point tended to confirm the general conclusions of our study since the intervention remained very attractive up to a discount of life years gained of 49%.

However, we made several important conservative assumptions in our model. Firstly, we cannot exclude that some of the cases classified as possibly effective were in fact effective. For instance, some of the referrals for obstructive labour, who underwent immediate caesarean section, could have suffered uterine rupture or fetal demise if referred by other means. Secondly, we excluded from the analysis the possible impact on the quality of life and disability. For instance, a prompt caesarean section for obstructive labour (one of the most frequent indications for referral) may prevent the development of vesicovaginal fistulae in the mother and disabilities in the newborns. The impact on the quality of life of these complications is overwhelming (Wall 2006). Moreover, in such contexts, characterized by high fertility rates, the prevalence of informal economy and the lack of a welfare system, prevention of maternal death deeply affects the entire households (Glasier *et al.* 2006). Thirdly, even though the ambulance is meant for obstetrical cases, it is inevitable (and desirable!) that it be also used for other indications. In our experience, for example, Health Centres frequently referred to the hospital critical children with severe anaemia who required immediate blood transfusion. The possible further benefits of these referrals were excluded from our analysis but they are presumably consistent. Fourthly, the proportion of women delivering in a health facility is still very low in Oyam district. As mentioned earlier, the rate of institutional deliveries is estimated to be 26% (Birungi *et al.* 2009). This is of relevance since the absolute number of women that is 'saved' by the referral is also important. As certain costs of the ambulance are stable and do not increase with the number of women

saved an increase in the absolute number may further enhance the cost effectiveness of the intervention. Fifthly, some cases were undoubtedly referred because of the lack of expert staff, drugs or equipment in the Health Centres. Staff trainings and supervisions took place before and during the program but more long-lasting efforts are presumably required. This aspect may however improve over time, thus reducing the costs of the service. Noteworthy, the decision to judge these cases as *not effective* led to an under estimation of the effectiveness of the ambulance service; some of them may in fact harbour effective referrals.

In conclusion, improving reproductive health requires a comprehensive set of interventions. Implementing a single option may not lead to worthwhile results. Of relevance in our intervention is that only 26% of the expected deliveries are conducted in the health facilities. Acting exclusively on the ambulance service will inevitably have limited effects on women delivering in an unsafe environment. Nevertheless, despite recognizing the outstanding value of this multilateral approach, our study also clearly emphasizes that the ambulance service plays a crucial role within the framework of these interventions. It is an essential part of it. The initial elevated capital costs should not discourage its implementation.

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