


RESEARCH ARTICLE

Open Access



Implementation of a referral and expert advice call Center for Maternal and Newborn Care in the resource constrained health system context of the Greater Accra region of Ghana

Ebenezer Oduro-Mensah^{1*} , Irene Akua Agyepong², Edith Frimpong², Marjolein Zweekhorst³ and Linda Amarkai Vanotoo⁴

Abstract

Background: Referral and clinical decision-making support are important for reducing delays in reaching and receiving appropriate and quality care. This paper presents analysis of the use of a pilot referral and decision making support call center for mothers and newborns in the Greater Accra region of Ghana, and challenges encountered in implementing such an intervention.

Methods: We analyzed longitudinal time series data from routine records of the call center over the first 33 months of its operation in Excel.

Results: During the first seventeen months of operation, the Information Communication Technology (ICT) platform was provided by the private telecommunication network MTN. The focus of the referral system was on maternal and newborn care. In this first phase, a total of 372 calls were handled by the center. 93% of the calls were requests for referral assistance (87% obstetric and 6% neonatal). The most frequent clinical reasons for maternal referral were prolonged labor (25%), hypertensive diseases in pregnancy (17%) and post-partum hemorrhage (7%). Birth asphyxia (58%) was the most common reason for neonatal referral. Inadequate bed space in referral facilities resulted in only 81% of referrals securing beds. The national ambulance service was able to handle only 61% of the requests for assistance with transportation because of its resource challenges. Resources could only be mobilized for the recurrent cost of running the center for 12 h (8.00 pm – 8.00 am) daily. During the second phase of the intervention we switched the use of the ICT platform to a free government platform operated by the National Security. In the next sixteen-month period when the focus was expanded to include all clinical cases, 390 calls were received with 51% being for medical emergency referrals and 30% for obstetrics and gynaecology emergencies. Request for bed space was honoured in 69% of cases.

(Continued on next page)

* Correspondence: ebomens78@yahoo.co.uk

¹Ghana Health Service, La General Hospital, PMB, La, Greater Accra Region, Accra, Ghana

Full list of author information is available at the end of the article



© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

(Continued from previous page)

Conclusions: The call center is a potentially useful and viable M-Health intervention to support referral and clinical decision making in the LMIC context of this study. However, health systems challenges such as inadequacy of human resources, unavailability of referral beds, poor health infrastructure, lack of recurrent financing and emergency transportation need to be addressed for optimal functioning.

Keywords: Implementation, Maternal health, Newborn health, Call center, Referral, Expert advice, Health systems

Background

Preventable Maternal and newborn morbidity and mortality are continuing challenges in low- and middle-income countries (LMIC); and Ghana like many of other countries in sub-Saharan Africa, was not able to attain Millennium Development Goal (MDG) 4 (reduce by two-thirds, between 1990 and 2015, the under-five mortality rate) and MDG 5 (reduce by three quarters between 1990 and 2015 the maternal mortality ratio) targets. Despite major drops in Under-five mortality failures in neonatal mortality decline drove in large part the failure to attain the MDG 4 target [1]. Similarly in relation to MDG 5, despite a fall in the maternal mortality ratio (MMR) from an estimated 740 maternal deaths per 100,000 live births in 1990 to 451 per 100,000 live births in 2008 [2], the rate of decline was and remained too slow over the era of the MDG. The averages moreover masked wide within country variation. The 2010 population and housing census estimated Ghana's MMR at 485 deaths per 100,000 live births with wide variation between regions from 355 in the Greater Accra region to 802 in the Upper East region [3].

Over two decades ago, Thaddeus and Maine after an exhaustive review of literature identified that delays in identifying and reaching the appropriate facility (type II delays) and the delays in receiving of quality care once the woman reaches the facility (type III delays) were major contributing causes of maternal morbidity and mortality in low and middle income countries [4]. The available evidence suggests that these delays are a continuing problem in Ghana. Although the government of Ghana introduced a policy exempting pregnant women and their newborns from paying for delivery care across the country in 2005, maternal and newborn mortality continued to remain high. Studies before and after the introduction of the policy identified the quality of care in health facilities, including provider decision making on management choices and poor referral practices in health facilities as a major contributor to the poor maternal and newborn outcomes [5, 6].

In 2011, the Regional Health Directorate (RHD) of the Greater Accra Region undertook a formative study in three districts in the Region to better understand the factors influencing decision making of frontline providers of maternal and newborn care, and what

interventions were required to support their decision making. The study found that apart from tacit knowledge and pre-existing knowledge providers sometimes consulted written protocols and guidelines depending on availability; and also informally used peer and expert consultation through face to face, phone calls, text messages and sometimes email. The choice depended on the urgency, the communication media available and staff familiarity with using the method. Health system constraints such as availability of staff, essential medicines, supplies and equipment as well as management issues and interpersonal relationships between staff and barriers to referral also influenced the quality of clinical decision making and potential related outcomes [7].

Among the interventions that frontline providers of maternal and newborn care felt would greatly facilitate and improve the quality and outcomes of their decision making was ready access to senior colleagues and experts for advice and support when managing obstetric and newborn emergencies, as well as an improved and coordinated referral process. As a follow up to this formative study, and working closely with the frontline providers of maternal and newborn health services in the Greater Accra region, a call center to support peer and expert consultation and referrals was designed by the Regional Health Directorate, with support from experts from the National ambulance Service and emergency clinicians.

The objectives for the design and implementation of the call center intervention were to improve maternal and neonatal health outcomes in the Greater Accra region by: (1) Facilitating the referral processes for maternal and newborn emergencies primarily (2) Providing reliable expert advice to frontline healthcare providers, (3) Identifying and assuring sustainable and affordable local financing for the recurrent maintenance costs of the intervention.

The call center was subsequently set up in partnership with a local private telecommunication network (MTN). The selection of the MTN as the local private telecommunication network to work with was based on evaluation of responses to an open call for proposals and quotations for support to develop a call center to support peer and expert consultation and coordinate referrals and expert advice in the region. An ethnographic

study of the organizational functioning of the call center has been published elsewhere and provides detail on how and why the center functioned including factors such as how staff were selected and remunerated, resources and working conditions etc. [1].

The objective of this complementary paper is to present the analysis of routine process indicators of how the call center facilitated (or not) referral for maternal and newborn emergencies and provision of expert advice to frontline health providers. In the process we also present some of the challenges of intervention development and implementation, innovation and research in a resource constrained context and the effects on the call centre intervention and its functioning. This paper focuses on a formative rather than a summative evaluation of the call Center intervention to generate information on “how” and “why” the intervention works (or not) that can help to interpret any outcomes in a summative evaluation.

Methods

Establishment and description of the call center intervention

The call center was established with local resources contributed by the hospitals and clinics in the region from their internally generated funds (IGF). IGF comprises client out of pocket payments and National Health Insurance scheme reimbursements. Health facilities within the Ghana Health Service in the Greater Accra region agreed to contribute a portion of their IGF, based on the size of the facility. The hospitals and clinics had been part of the design of the intervention; and saw it as a response to a felt need. The fact that the agenda setting was led by and the implementation of the formative research and design of the intervention were done as a close collaborative effort with the Ghana Health Service regional, district and hospital managers as well as frontline workers in the region enabled this strong sense of ownership. The amounts were agreed on by consensus taking into account their IGF income and were the Ghana cedi equivalent of USD 600 for hospitals, USD460 for polyclinics. The smaller facilities (health centres) and small clinics with less revenue did not contribute. Ten (10) hospitals and six (6) polyclinics contributed approximately USD 15,000. This was many times less than the budget estimates that were made calculated as needed to run the intervention full scale 24 h daily and conduct formative as well as summative evaluation. The IGF contributions were paid into a pooled

fund coordinated by the Greater Accra Regional Health Directorate (RHD).

Space for the housing of the center, and the costs of shared overheads such as electricity and water was provided by the Ridge Regional Hospital Out-Patients Department (OPD), Adabraka (now Adabraka Polyclinic). The Free University of Amsterdam Athena Center, as part of a research collaboration contributed through the University of Ghana's School of Public Health, an amount of Nine thousand nine hundred and fifty Euro (€9950.00) to support the initial monitoring and documentation of the center and its effects and outputs. Beyond this there was no dedicated funding for the establishment and recurrent costs of the intervention or its monitoring and evaluation. The need to manage within these severe resource constraints was an important factor affecting how and why the intervention was implemented.

A series of stakeholder meetings were held with heads of referring (smaller hospitals and polyclinics) and receiving (larger hospitals, including secondary and tertiary) facilities to discuss and refine the modalities for the setup and functioning of the center and make sure they were responsive to the felt needs of the providers. MTN Ghana, a private telecom operator, set up the equipment to provide the Telecommunication backbone for the center between February and March 2015. The call center started full operations on 12th April 2015. The service was advertised only to the frontline health workers who refer and the receiving hospitals who take the referrals through these stakeholder engagements with facilities and their managers. These staff were regarded as the direct potential population being served by the call center or the primary users. All frontline health workers within the various health facilities within Greater Accra region (over 11 hospital, 11 polyclinics, 16 health centers, over 30 private hospitals etc.) were all part of the target population for this intervention as well as the referral hospitals receiving patients from all lower level hospitals within the region. The clients who were referred or received referral services through the center were regarded as the indirect potential population to be served by the center. This is because these clients themselves were not the ones who took the decision to use the center or who contacted the call center for service once the decision was taken. No specific advertising was targeted at clients therefore. However, our ultimate goal was to improve the health and wellbeing of the clients.

Functional setup and operations of the center

The Regional Call Center at inception was staffed by 8 officers who worked on a shift system. They were assisted by an administrative assistant, and supervised by a coordinator. The 8 officers comprised 3 midwives, 3

¹Frimpong E., Oduro-Mensah E., Vanotoo L. & Agyepong I.A. (2018). An exploratory study of the organizational functioning of a decision making and referral support call center for frontline providers of maternal and newborn care in the Greater Accra region of Ghana. *International Journal of Health Planning and Management* 2018; 1–12

general nurses and 2 national service persons. They were trained on how to operate the center using the Ghana Safe Motherhood protocols over a two-day period in March 2015 by the Chief Nursing Office, the Deputy Director of Nursing in charge of Clinical Care and Emergencies, the Call Center Coordinator, staff of the Institutional Care Division of the Ghana Health Service and the National Ambulance Service. These officers were responsible for carrying out the technical functions of the call center i.e. coordinating access to expert support and referral coordination. The center operated under the office of the Regional Director of Health Services. The coordinator had oversight responsibility for the day-to-day running of the facility. The center primarily supported maternal and neonatal units of all health facilities within the region for two main functions of the coordination of expert advice and referrals.

Coordinating expert advice

To coordinate expert advice, the center worked with an expert panel of senior practitioners to aid frontline maternal and newborn health (MNH) service providers at all levels of care in the region. Frontline service providers were able to reach the experts by a phone call routed through the center. The expert panel had a membership of three obstetricians, two paediatricians, the regional pharmacist and an anaesthetist. These officers were employees of the Ghana Health Service and did not receive any special remuneration for providing advice. It was treated as part of their normal work. The center officers received calls for help directly from

frontline health service providers, and immediately transferred the call to the appropriate expert panel member based on the nature of the request. Follow up officers were as part of the standard operating procedure (SOP) required to call health facilities back within 15 min of transferring their calls to the expert panel members for feedback. Where a referral was required, either by information from the expert panel or feedback from the health facility, the follow-up officers proceeded to arrange for the referral. This mechanism is illustrated in Fig. 1.

Coordinating referrals of emergencies

The call center coordinated referrals between health facilities, based on bed availability and the availability of personnel to manage the patient’s condition. Staff of the Call Center worked closely with the National Ambulance Service (NAS) and the major referral hospitals in Accra (Ridge Regional Hospital, Tema General Hospital, LEKMA Hospital, La General Hospital, Achimota Hospital, Pentecost Hospital, Korle-Bu Teaching Hospital and 37 Military Hospital) to ensure that referrals were handled efficiently.

When a frontline worker needed to refer an emergency, a call was placed by the frontline worker to the call center. The officer at the center answered the call and conducted a brief telephone interview of the caller to document the details of the call on the Call Center Documentation form, and then transferred the call to the follow-up officer. It was the responsibility of the follow-up officer to ensure that a bed was secured in a

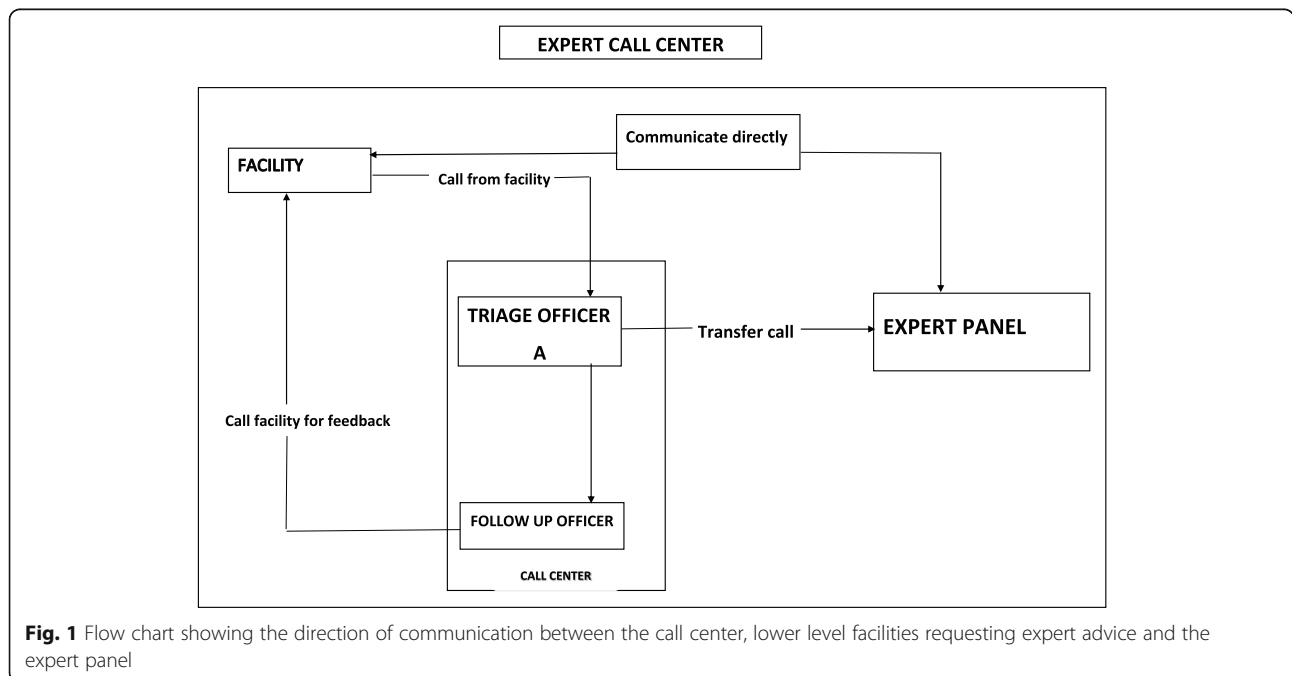


Fig. 1 Flow chart showing the direction of communication between the call center, lower level facilities requesting expert advice and the expert panel

health facility and an ambulance was dispatched where possible to transport the patient to the receiving facility (Fig. 2). This was to ensure that effective inter-facility referral communications were made before referrals with the main aim of ensuring that receiving facilities were pre-informed and were ready to receive the patients.

In all cases, it was Standard Operating Procedure (SOP) for any missed phone call to be returned within 15 min. Call logs on the phones were routinely checked to verify this. It is however possible that a few calls may have been missed and therefore, not documented.

Phases of operation of the call center

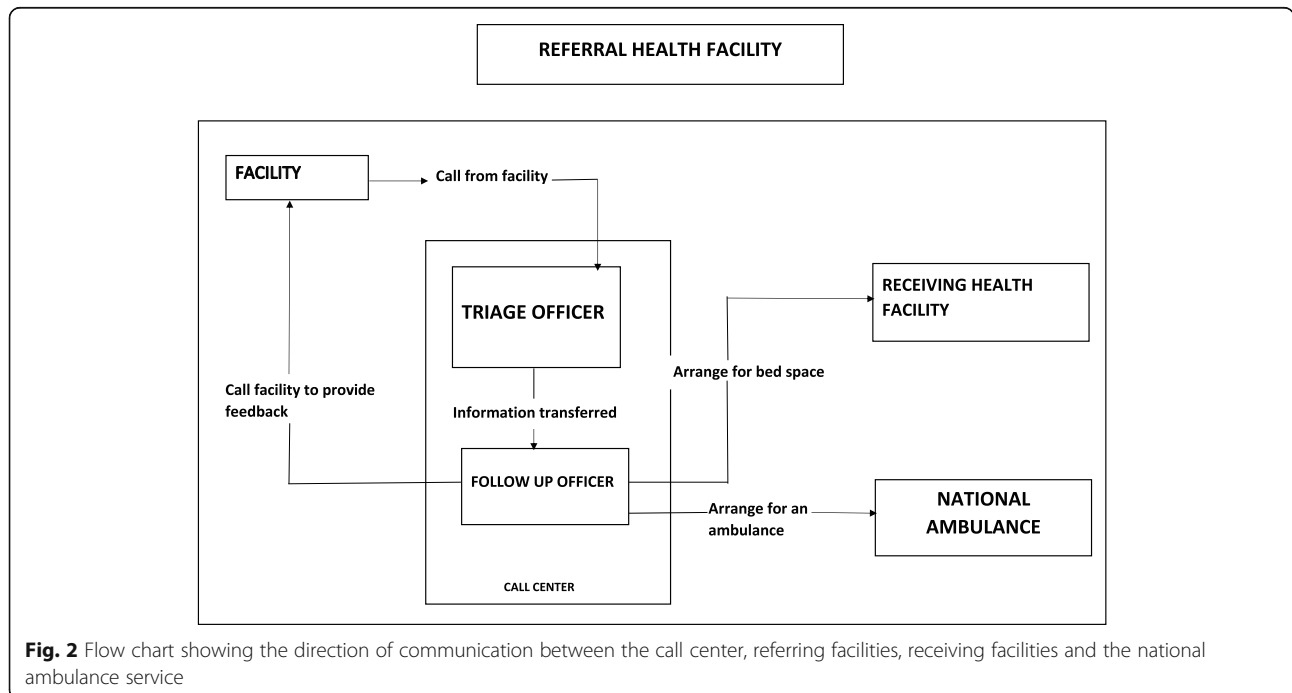
Phases of operation of the call center can be split into the first 17 months (phase 1) when a private telecommunications company, MTN, providing the ICT platform (April 2015 to August 2016) and the period after the exit of MTN (phase 2) when the platform relied on the limited but free Gota phone system provided by National Security.

Phase one: April 2015 – august 2016 (17 months)

The center operated with a backbone support for the Information Communication Technology (ICT) equipment provided by MTN Ghana. Operations started with 6 triage officers (3 midwives, 3 general nurses) and two national service personnel. The staff operated from 8 pm to 8 am i.e. run 12-h night shifts, with at least one midwife and one general nurse on duty per shift. Calls expected to be received at the center were to be for either

expert advice or referral purposes. The running of 24-h services in phase 1 was constrained by inadequate resources for the recurrent operational costs. The original concept and design was for 24 h but faced with these resource constraints, priority was given to operating the center between 8 pm to 8 am, when the need for expert or specialist support for frontline health workers was greatest. The extra resources that were not immediately available to make a 24-h service possible were mainly for recurrent costs such as phone bills, stationery, additional staff, staff training etc. The challenge occurred because health facilities that had initially pledged to make financial contributions to support the center reneged on their pledges as they themselves struggled with inadequate financing. Ghana has moved to lower middle-income status and many development partners that supported the health sector are transitioning out. Unfortunately, resources available for service delivery at the frontline from government taxes are also declining.

Apart from the startup costs already described, health facilities had agreed and were required to make recurrent monthly contributions to the regional health directorate to help pay for the cost of maintaining the contract with MTN Ghana. As these payments continued not to be made as agreed, the service provide MTN Ghana could not be paid and they eventually disconnected the phone lines of the center on 31st August 2016. This challenge was addressed when the National level took an interest in the center’s activities, and provided GOTA phones and additional staffing to man the center in September 2016.



Phase two: September 2016 – December 2017 (16 months) With the discontinuation by MTN of its support to the center because it was unable to meet the recurrent cost, the center from September 2016 operated with GOTA phones which are dedicated security phones donated by the National Security Service through the Ghana Health Service. Cordless and mobile GOTA phones were also distributed across most health facilities. In all, twelve facilities received cordless referral Gota phones. This was made up of nine (9) Ghana Health facilities, two (2) quasi-government hospitals and one (1) teaching hospital. A phone was also given to the National Ambulance Service. All health facilities who received Gota phones were referral level hospitals i.e. received emergencies from lower level health facilities.

These advantage of these phones and the service was that they were provided free by government. The disadvantage was that the scope of service available under this system was less than under the commercial system run by MTN and they could not be used for conference calling, call transfers and expert advice. Hence, the role of the call center in providing expert advice was curtailed. The center could now only support referrals between facilities.

The introduction of the Gota phones, and provision of extra staff for the call center by government through the Regional Health Directorate allowed a decision to run the center for 24 h instead of 12 h, and to open the center to receive calls for all clinical emergencies, not just maternal and newborn care. Additional personnel were trained and brought on board, making a total of 10 officers (5 clinical staff and 5 non-clinical staff, with the sixth clinical staff taking up other duties in another unit). These officers run 12 h shifts i.e. day and night duties; with at least two on duty in a given shift.

Post phase 1 and 2

The call center has continued to operate after this 33-month pilot period, and has been upgraded to a teleconsultation center by the Ghana Health Service.

Study design, data collection methods and analysis

Study design

The study design was a longitudinal time series routine data analysis of process indicators of the immediate outcomes of call center functioning over a 33-month period starting from April 2015 when the centre commenced operation. This covers the 17 months of phase 1 and an almost equivalent period of 16 months of phase 2.

Data collection methods and analysis

At inception of the operation of the center, a simple form (Supplementary 1) was designed for the call center staff to manually fill as they responded to calls. The staff

documented on this form, each call, made to the call center, the source clinic or hospital (including caller and phone number), referral diagnoses, cases received at first attempt, those received at subsequent attempts, outcomes of referrals and expert advice. The advice algorithm used by the staff at the call centre to guide their decision making on each call is attached as Tables 1 & 2.

Some receiving facilities failed to respond when their emergency lines were called on some days, or had their phones off, making it difficult for the call center to reach them. Some staff members were delegated as focal persons for the call center in their health facilities. Their role was to coordinate activities of the call center within their facilities, providing regular updates on the bed states of their facilities and serving as a point of contact if the call center is facing difficulties accessing a bed. However, follow-up officers were not able to perform this task as no phones were provided for them specifically for this role due to the financial constraints under which the intervention was implemented. The data generated was regularly checked for completeness and consistency and then entered into Excel. We analyzed this data in Excel for frequencies and trends.

Results

Phase one: MTN as the ICT platform handler (April 2015 – august 2016)

A total of 372 calls were handled by the call center between 15th April 2015 and 30th August 2016 when the ICT platform was handled by the private telco, MTN. Just about 2.4% of these calls were requests for expert advice (1.9% for obstetrics and 0.5% for neonatal conditions), while 93% of calls received were requests for referrals (Table 3).

Most calls were recorded between the hours of 9 pm in the evening and 12midnight and between 6 am to 7: 30 am. With regards to request for referrals, about 86.6% (322 out of 362 calls) were requests for obstetric referrals and a few were for neonatal referrals (24 cases). Though designed specifically for maternal and newborn care, the center was not completely restricted to these cases. It also received a few requests (16 calls total, 4.3% of all calls) to support the referral of general medical and surgical emergencies such as severe anemia and severe hypertension. There were two (2) requests for ambulance support.

Reasons for referral

Referring facilities gave several reasons why they needed to refer their patients. The health system factor underlying most referrals was the unavailability of skilled personnel to handle the complications of labour and delivery at the point of referral. The clinical reasons for obstetric referral are presented in Table 4, with the most

Table 1 Maternal protocol for call center

ANAEMIA	Hb 7-11g/dl	Ensure balanced diet, fesoate twice daily, folic acid 5mg daily. Reassess in 2 weeks, no improvement – organize donors & refer	
	Hb ≤7g/dl	Check vitals, +/- oxygen, GXM, organize donors & Refer	
ANTEPARTUM HAEMORRHAGE	PLACENTA ABRUPTION	Assess blood loss, vitals, FH, O ₂ , GXM, run NS/RL fast, bedside clotting, pass catheter, transfuse if needed. Delivery not imminent – Refer	
	PLACENTA PREVIA	No VE , assess blood loss, vitals, FH, O ₂ , 2 wide bore cannulae, GXM, run NS/RL, pass catheter, transfuse if needed, Refer + run IVF	
FEVER ≥38°C	MALARIA	Positive malaria test + signs of complicated malaria: check vitals, IV fluids, IV/IM artesunate/quinine, paracetamol – refer if needed	
	Urinary Tract Infection	Signs and symptoms of UTI present + Negative malaria test: Give broad spectrum antibiotics, review in 3 days. Persistent symptoms – refer	
	Respiratory Tract Infection	Signs and symptoms of RTI present + Negative malaria test: Give broad spectrum antibiotics, review in 3 days. Persistent symptoms – refer	
EARLY VAGINAL BLEEDING, <28WEEKS	COMPLICATED/ SEPTIC ABORTION	Profuse bleeding/ shock: IVF, O ₂ , GXM, IM Syntocinon 10IU stat, IV antibiotics, transfuse if needed, NVA, if trained, otherwise refer	
	ECTOPIC	Check vitals, UPT: GXM, O ₂ , run NS/RL, transfuse if needed. Pass catheter, counsel for surgery, continue monitoring. refer + run IVF	
MOLAR PREGNANCY		Counsel/reassure, vitals: Profuse bleeding/ shock – resuscitate, GXM, transfuse if needed & refer . Add any expelled products	
FEVER ≥38°C	MALARIA	Positive malaria test + signs of complicated malaria: check vitals, IV fluids, IV/IM artesunate/quinine, paracetamol – refer if needed	
	Urinary Tract Infection	Signs and symptoms of UTI present + Negative malaria test: Give broad spectrum antibiotics, review in 3 days. Persistent symptoms – refer	
	Respiratory Tract Infection	Signs and symptoms of RTI present + Negative malaria test: Give broad spectrum antibiotics, review in 3 days. Persistent symptoms – refer	
CHORIOAMNIONITIS		Offensive discharge, abdominal pain + Negative malaria test: Give broad spectrum antibiotics (Amp, Gent, Flagyl), check vitals, FH – refer	
HYPERTENSION	DIASTOLIC BP ≥ 100mmHg, <20 weeks	Refer if DBP remains persistently over one week apart	
	DIASTOLIC BP ≥ 100mmHg, <20 weeks	Give oral nifedipine 20-40mg stat, Refer if doctor is not available.	
	DIASTOLIC BP ≥ 100mmHg +/- 20 weeks	If headache, blurred vision, epigastric pain & edema present; pass catheter & give 14g MgSO ₄ loading stat. Refer	
	DIASTOLIC BP ≥ 100mmHg +/- 20 weeks	If headache, blurred vision, epigastric pain, edema present; pass catheter, give oral nifedipine 20-40mg stat. & 14g MgSO ₄ stat. Refer	
ECLAMPSIA		Call help, ABC, left lateral position, O ₂ , GXM, 14g MgSO ₄ stat., pass catheter, vitals, FH, delivery not imminent – refer , delivered – refer	
OTHER CONDITIONS	FETAL DISTRESS	Left lateral side, stop IV syntocinon, O ₂ , GXM, run NS/RL fast, pass catheter, VE Persistent after 30minutes refer for urgent delivery	
	HYPEREMESIS	Deplete, weight, NPO 24 hours, nil per os, change to oral when vomiting stops, refer if no improvement after 24hours	
	PREMATURE RUPTURE OF MEMBRANES <37weeks	No vaginal exam , do speculum exam, assess SFH, PH. Give IM dexamethasone 6mg stat, & tab Erythromycin and flagyl. Refer	
	PREMATURE RUPTURE OF MEMBRANES >37weeks	Do speculum (if labour), assess SFH, PH. Give antibiotics if >6 hours, Refer – infection, PROM>24hrs, fetal distress, labour>12 hours	
	SHOULDER DYSTOCIA	Call for help, empty bladder quickly, position at bed edge, give episiotomy, flex thighs on abdomen, apple cupped against perineum, deliver	
	CORD PROLAPSE	Check FM/CD outflow, VE , pass catheter, instil 500ml NS in bladder, O ₂ , put in left lateral, prepare for vacuum delivery/ C/S refer	
	1. POST PARTUM HAEMORRHAGE	1. ATONIC UTERUS	Call help, rub uterus, 2 wide bore cannulae, GXM, run NS/RL fast, pass catheter, Syntocinon 20IU in 500ml NS + 4 tablets rectal cytotec
		2. LOWER GENITAL TEARS	Run NS/RL fast, clockwise speculum exam of cervix with 2 sponge forceps in light, identify & repair minor tears, pack & refer major tears
		3. RUPTURED UTERUS	Call help, 2 wide bore cannulae, GXM, run NS/RL fast, O ₂ , monitor vitals, pass catheter, transfuse if needed. Refer + run IVF
		4. INVERTED UTERUS	Call help, 2 wide bore cannulae, GXM, run NS/RL fast, O ₂ , antibiotics, monitor vitals, pass catheter, transfuse if needed. Refer + run IVF
5. RETAINED PLACENTA	Call help, 2 wide bore cannulae, GXM, run NS/RL fast, pass catheter, syntocinon 20IU in 500ml NS, ICU, antibiotics, manual removal/ refer		
PROLONGED LABOUR	CEPHALOPELVIC DISPROPORTION	Check vitals, FH, IV access: Run 500ml NS/RL, GXM, oxygen, pass catheter, IV antibiotics (Amp, Gent, Flagyl), counsel, refer for C/S	
	OBSTRUCTED LABOUR	Check vitals, FH, IV access: Run NS/RL, oxygen, GXM, pass catheter, IV antibiotics (Amp, Gent, Flagyl), pain relief, counsel, refer for C/S	

Table 2 Newborn protocol for call center

Diagnosis	Specific problems	Management	
Abnormal breathing	Birth Asphyxia	Resuscitate baby, Oxygen, IM Crystalline Penicillin (5000units/kg), IM Phenobarbitone (20mg/kg). See under birth asphyxia. Refer	
	Neonatal Sepsis	Determine cause, give IM X Pen (50000units/kg) and Gentamycin (2.5mg/kg). See under neonatal sepsis	
	Aspiration of feed	Stop feeds, Suction airway, give Oxygen, IM Crystalline Penicillin (5000units/kg), Gentamycin (2.5mg/kg), Metronidazole (7.5mg/kg) Refer	
	Pallor	Keep warm and give Oxygen (0.5L-1L/min) by nasal prongs. Refer	
	Mecconium Aspiration	Suction, keep warm, give Oxygen (0.5L-1L/min), IM X Pen (50000units/kg), Gentamycin (2.5mg/kg), IV 10% Dextrose. Refer	
	Diagnosis	Specific problems	Management
Birth Asphyxia		Synex	Pre-vent ventilation or intubation, IFHR <100/min, do slow compression, give IM adrenaline (1:1000 0.1ml) for 10sec, while compressing
Difficultly breathing		Give Oxygen (0.5L-1L/min) by nasal prongs face mask, DO NOT feed baby, Give IPF Dextrose (1.5 NS in 10% Dextrose) Refer	
Unable to suck		DO NOT hold baby, Give IPF Dextrose (1.5 NS in 10% Dextrose) Refer	
Lethargic/irritability		IPF test at 1h, IPF test at 2h, IPF test at 3h, IPF test at 4h, IPF test at 5h, IPF test at 6h, IPF test at 7h, IPF test at 8h, IPF test at 9h, IPF test at 10h, IPF test at 11h, IPF test at 12h, IPF test at 13h, IPF test at 14h, IPF test at 15h, IPF test at 16h, IPF test at 17h, IPF test at 18h, IPF test at 19h, IPF test at 20h, IPF test at 21h, IPF test at 22h, IPF test at 23h, IPF test at 24h, IPF test at 25h, IPF test at 26h, IPF test at 27h, IPF test at 28h, IPF test at 29h, IPF test at 30h, IPF test at 31h, IPF test at 32h, IPF test at 33h, IPF test at 34h, IPF test at 35h, IPF test at 36h, IPF test at 37h, IPF test at 38h, IPF test at 39h, IPF test at 40h, IPF test at 41h, IPF test at 42h, IPF test at 43h, IPF test at 44h, IPF test at 45h, IPF test at 46h, IPF test at 47h, IPF test at 48h, IPF test at 49h, IPF test at 50h, IPF test at 51h, IPF test at 52h, IPF test at 53h, IPF test at 54h, IPF test at 55h, IPF test at 56h, IPF test at 57h, IPF test at 58h, IPF test at 59h, IPF test at 60h, IPF test at 61h, IPF test at 62h, IPF test at 63h, IPF test at 64h, IPF test at 65h, IPF test at 66h, IPF test at 67h, IPF test at 68h, IPF test at 69h, IPF test at 70h, IPF test at 71h, IPF test at 72h, IPF test at 73h, IPF test at 74h, IPF test at 75h, IPF test at 76h, IPF test at 77h, IPF test at 78h, IPF test at 79h, IPF test at 80h, IPF test at 81h, IPF test at 82h, IPF test at 83h, IPF test at 84h, IPF test at 85h, IPF test at 86h, IPF test at 87h, IPF test at 88h, IPF test at 89h, IPF test at 90h, IPF test at 91h, IPF test at 92h, IPF test at 93h, IPF test at 94h, IPF test at 95h, IPF test at 96h, IPF test at 97h, IPF test at 98h, IPF test at 99h, IPF test at 100h, IPF test at 101h, IPF test at 102h, IPF test at 103h, IPF test at 104h, IPF test at 105h, IPF test at 106h, IPF test at 107h, IPF test at 108h, IPF test at 109h, IPF test at 110h, IPF test at 111h, IPF test at 112h, IPF test at 113h, IPF test at 114h, IPF test at 115h, IPF test at 116h, IPF test at 117h, IPF test at 118h, IPF test at 119h, IPF test at 120h, IPF test at 121h, IPF test at 122h, IPF test at 123h, IPF test at 124h, IPF test at 125h, IPF test at 126h, IPF test at 127h, IPF test at 128h, IPF test at 129h, IPF test at 130h, IPF test at 131h, IPF test at 132h, IPF test at 133h, IPF test at 134h, IPF test at 135h, IPF test at 136h, IPF test at 137h, IPF test at 138h, IPF test at 139h, IPF test at 140h, IPF test at 141h, IPF test at 142h, IPF test at 143h, IPF test at 144h, IPF test at 145h, IPF test at 146h, IPF test at 147h, IPF test at 148h, IPF test at 149h, IPF test at 150h, IPF test at 151h, IPF test at 152h, IPF test at 153h, IPF test at 154h, IPF test at 155h, IPF test at 156h, IPF test at 157h, IPF test at 158h, IPF test at 159h, IPF test at 160h, IPF test at 161h, IPF test at 162h, IPF test at 163h, IPF test at 164h, IPF test at 165h, IPF test at 166h, IPF test at 167h, IPF test at 168h, IPF test at 169h, IPF test at 170h, IPF test at 171h, IPF test at 172h, IPF test at 173h, IPF test at 174h, IPF test at 175h, IPF test at 176h, IPF test at 177h, IPF test at 178h, IPF test at 179h, IPF test at 180h, IPF test at 181h, IPF test at 182h, IPF test at 183h, IPF test at 184h, IPF test at 185h, IPF test at 186h, IPF test at 187h, IPF test at 188h, IPF test at 189h, IPF test at 190h, IPF test at 191h, IPF test at 192h, IPF test at 193h, IPF test at 194h, IPF test at 195h, IPF test at 196h, IPF test at 197h, IPF test at 198h, IPF test at 199h, IPF test at 200h, IPF test at 201h, IPF test at 202h, IPF test at 203h, IPF test at 204h, IPF test at 205h, IPF test at 206h, IPF test at 207h, IPF test at 208h, IPF test at 209h, IPF test at 210h, IPF test at 211h, IPF test at 212h, IPF test at 213h, IPF test at 214h, IPF test at 215h, IPF test at 216h, IPF test at 217h, IPF test at 218h, IPF test at 219h, IPF test at 220h, IPF test at 221h, IPF test at 222h, IPF test at 223h, IPF test at 224h, IPF test at 225h, IPF test at 226h, IPF test at 227h, IPF test at 228h, IPF test at 229h, IPF test at 230h, IPF test at 231h, IPF test at 232h, IPF test at 233h, IPF test at 234h, IPF test at 235h, IPF test at 236h, IPF test at 237h, IPF test at 238h, IPF test at 239h, IPF test at 240h, IPF test at 241h, IPF test at 242h, IPF test at 243h, IPF test at 244h, IPF test at 245h, IPF test at 246h, IPF test at 247h, IPF test at 248h, IPF test at 249h, IPF test at 250h, IPF test at 251h, IPF test at 252h, IPF test at 253h, IPF test at 254h, IPF test at 255h, IPF test at 256h, IPF test at 257h, IPF test at 258h, IPF test at 259h, IPF test at 260h, IPF test at 261h, IPF test at 262h, IPF test at 263h, IPF test at 264h, IPF test at 265h, IPF test at 266h, IPF test at 267h, IPF test at 268h, IPF test at 269h, IPF test at 270h, IPF test at 271h, IPF test at 272h, IPF test at 273h, IPF test at 274h, IPF test at 275h, IPF test at 276h, IPF test at 277h, IPF test at 278h, IPF test at 279h, IPF test at 280h, IPF test at 281h, IPF test at 282h, IPF test at 283h, IPF test at 284h, IPF test at 285h, IPF test at 286h, IPF test at 287h, IPF test at 288h, IPF test at 289h, IPF test at 290h, IPF test at 291h, IPF test at 292h, IPF test at 293h, IPF test at 294h, IPF test at 295h, IPF test at 296h, IPF test at 297h, IPF test at 298h, IPF test at 299h, IPF test at 300h, IPF test at 301h, IPF test at 302h, IPF test at 303h, IPF test at 304h, IPF test at 305h, IPF test at 306h, IPF test at 307h, IPF test at 308h, IPF test at 309h, IPF test at 310h, IPF test at 311h, IPF test at 312h, IPF test at 313h, IPF test at 314h, IPF test at 315h, IPF test at 316h, IPF test at 317h, IPF test at 318h, IPF test at 319h, IPF test at 320h, IPF test at 321h, IPF test at 322h, IPF test at 323h, IPF test at 324h, IPF test at 325h, IPF test at 326h, IPF test at 327h, IPF test at 328h, IPF test at 329h, IPF test at 330h, IPF test at 331h, IPF test at 332h, IPF test at 333h, IPF test at 334h, IPF test at 335h, IPF test at 336h, IPF test at 337h, IPF test at 338h, IPF test at 339h, IPF test at 340h, IPF test at 341h, IPF test at 342h, IPF test at 343h, IPF test at 344h, IPF test at 345h, IPF test at 346h, IPF test at 347h, IPF test at 348h, IPF test at 349h, IPF test at 350h, IPF test at 351h, IPF test at 352h, IPF test at 353h, IPF test at 354h, IPF test at 355h, IPF test at 356h, IPF test at 357h, IPF test at 358h, IPF test at 359h, IPF test at 360h, IPF test at 361h, IPF test at 362h, IPF test at 363h, IPF test at 364h, IPF test at 365h, IPF test at 366h, IPF test at 367h, IPF test at 368h, IPF test at 369h, IPF test at 370h, IPF test at 371h, IPF test at 372h, IPF test at 373h, IPF test at 374h, IPF test at 375h, IPF test at 376h, IPF test at 377h, IPF test at 378h, IPF test at 379h, IPF test at 380h, IPF test at 381h, IPF test at 382h, IPF test at 383h, IPF test at 384h, IPF test at 385h, IPF test at 386h, IPF test at 387h, IPF test at 388h, IPF test at 389h, IPF test at 390h, IPF test at 391h, IPF test at 392h, IPF test at 393h, IPF test at 394h, IPF test at 395h, IPF test at 396h, IPF test at 397h, IPF test at 398h, IPF test at 399h, IPF test at 400h, IPF test at 401h, IPF test at 402h, IPF test at 403h, IPF test at 404h, IPF test at 405h, IPF test at 406h, IPF test at 407h, IPF test at 408h, IPF test at 409h, IPF test at 410h, IPF test at 411h, IPF test at 412h, IPF test at 413h, IPF test at 414h, IPF test at 415h, IPF test at 416h, IPF test at 417h, IPF test at 418h, IPF test at 419h, IPF test at 420h, IPF test at 421h, IPF test at 422h, IPF test at 423h, IPF test at 424h, IPF test at 425h, IPF test at 426h, IPF test at 427h, IPF test at 428h, IPF test at 429h, IPF test at 430h, IPF test at 431h, IPF test at 432h, IPF test at 433h, IPF test at 434h, IPF test at 435h, IPF test at 436h, IPF test at 437h, IPF test at 438h, IPF test at 439h, IPF test at 440h, IPF test at 441h, IPF test at 442h, IPF test at 443h, IPF test at 444h, IPF test at 445h, IPF test at 446h, IPF test at 447h, IPF test at 448h, IPF test at 449h, IPF test at 450h, IPF test at 451h, IPF test at 452h, IPF test at 453h, IPF test at 454h, IPF test at 455h, IPF test at 456h, IPF test at 457h, IPF test at 458h, IPF test at 459h, IPF test at 460h, IPF test at 461h, IPF test at 462h, IPF test at 463h, IPF test at 464h, IPF test at 465h, IPF test at 466h, IPF test at 467h, IPF test at 468h, IPF test at 469h, IPF test at 470h, IPF test at 471h, IPF test at 472h, IPF test at 473h, IPF test at 474h, IPF test at 475h, IPF test at 476h, IPF test at 477h, IPF test at 478h, IPF test at 479h, IPF test at 480h, IPF test at 481h, IPF test at 482h, IPF test at 483h, IPF test at 484h, IPF test at 485h, IPF test at 486h, IPF test at 487h, IPF test at 488h, IPF test at 489h, IPF test at 490h, IPF test at 491h, IPF test at 492h, IPF test at 493h, IPF test at 494h, IPF test at 495h, IPF test at 496h, IPF test at 497h, IPF test at 498h, IPF test at 499h, IPF test at 500h, IPF test at 501h, IPF test at 502h, IPF test at 503h, IPF test at 504h, IPF test at 505h, IPF test at 506h, IPF test at 507h, IPF test at 508h, IPF test at 509h, IPF test at 510h, IPF test at 511h, IPF test at 512h, IPF test at 513h, IPF test at 514h, IPF test at 515h, IPF test at 516h, IPF test at 517h, IPF test at 518h, IPF test at 519h, IPF test at 520h, IPF test at 521h, IPF test at 522h, IPF test at 523h, IPF test at 524h, IPF test at 525h, IPF test at 526h, IPF test at 527h, IPF test at 528h, IPF test at 529h, IPF test at 530h, IPF test at 531h, IPF test at 532h, IPF test at 533h, IPF test at 534h, IPF test at 535h, IPF test at 536h, IPF test at 537h, IPF test at 538h, IPF test at 539h, IPF test at 540h, IPF test at 541h, IPF test at 542h, IPF test at 543h, IPF test at 544h, IPF test at 545h, IPF test at 546h, IPF test at 547h, IPF test at 548h, IPF test at 549h, IPF test at 550h, IPF test at 551h, IPF test at 552h, IPF test at 553h, IPF test at 554h, IPF test at 555h, IPF test at 556h, IPF test at 557h, IPF test at 558h, IPF test at 559h, IPF test at 560h, IPF test at 561h, IPF test at 562h, IPF test at 563h, IPF test at 564h, IPF test at 565h, IPF test at 566h, IPF test at 567h, IPF test at 568h, IPF test at 569h, IPF test at 570h, IPF test at 571h, IPF test at 572h, IPF test at 573h, IPF test at 574h, IPF test at 575h, IPF test at 576h, IPF test at 577h, IPF test at 578h, IPF test at 579h, IPF test at 580h, IPF test at 581h, IPF test at 582h, IPF test at 583h, IPF test at 584h, IPF test at 585h, IPF test at 586h, IPF test at 587h, IPF test at 588h, IPF test at 589h, IPF test at 590h, IPF test at 591h, IPF test at 592h, IPF test at 593h, IPF test at 594h, IPF test at 595h, IPF test at 596h, IPF test at 597h, IPF test at 598h, IPF test at 599h, IPF test at 600h, IPF test at 601h, IPF test at 602h, IPF test at 603h, IPF test at 604h, IPF test at 605h, IPF test at 606h, IPF test at 607h, IPF test at 608h, IPF test at 609h, IPF test at 610h, IPF test at 611h, IPF test at 612h, IPF test at 613h, IPF test at 614h, IPF test at 615h, IPF test at 616h, IPF test at 617h, IPF test at 618h, IPF test at 619h, IPF test at 620h, IPF test at 621h, IPF test at 622h, IPF test at 623h, IPF test at 624h, IPF test at 625h, IPF test at 626h, IPF test at 627h, IPF test at 628h, IPF test at 629h, IPF test at 630h, IPF test at 631h, IPF test at 632h, IPF test at 633h, IPF test at 634h, IPF test at 635h, IPF test at 636h, IPF test at 637h, IPF test at 638h, IPF test at 639h, IPF test at 640h, IPF test at 641h, IPF test at 642h, IPF test at 643h, IPF test at 644h, IPF test at 645h, IPF test at 646h, IPF test at 647h, IPF test at 648h, IPF test at 649h, IPF test at 650h, IPF test at 651h, IPF test at 652h, IPF test at 653h, IPF test at 654h, IPF test at 655h, IPF test at 656h, IPF test at 657h, IPF test at 658h, IPF test at 659h, IPF test at 660h, IPF test at 661h, IPF test at 662h, IPF test at 663h, IPF test at 664h, IPF test at 665h, IPF test at 666h, IPF test at 667h, IPF test at 668h, IPF test at 669h, IPF test at 670h, IPF test at 671h, IPF test at 672h, IPF test at 673h, IPF test at 674h, IPF test at 675h, IPF test at 676h, IPF test at 677h, IPF test at 678h, IPF test at 679h, IPF test at 680h, IPF test at 681h, IPF test at 682h, IPF test at 683h, IPF test at 684h, IPF test at 685h, IPF test at 686h, IPF test at 687h, IPF test at 688h, IPF test at 689h, IPF test at 690h, IPF test at 691h, IPF test at 692h, IPF test at 693h, IPF test at 694h, IPF test at 695h, IPF test at 696h, IPF test at 697h, IPF test at 698h, IPF test at 699h, IPF test at 700h, IPF test at 701h, IPF test at 702h, IPF test at 703h, IPF test at 704h, IPF test at 705h, IPF test at 706h, IPF test at 707h, IPF test at 708h, IPF test at 709h, IPF test at 710h, IPF test at 711h, IPF test at 712h, IPF test at 713h, IPF test at 714h, IPF test at 715h, IPF test at 716h, IPF test at 717h, IPF test at 718h, IPF test at 719h, IPF test at 720h, IPF test at 721h, IPF test at 722h, IPF test at 723h, IPF test at 724h, IPF test at 725h, IPF test at 726h, IPF test at 727h, IPF test at 728h, IPF test at 729h, IPF test at 730h, IPF test at 731h, IPF test at 732h, IPF test at 733h, IPF test at 734h, IPF test at 735h, IPF test at 736h, IPF test at 737h, IPF test at 738h, IPF test at 739h, IPF test at 740h, IPF test at 741h, IPF test at 742h, IPF test at 743h, IPF test at 744h, IPF test at 745h, IPF test at 746h, IPF test at 747h, IPF test at 748h, IPF test at 749h, IPF test at 750h, IPF test at 751h, IPF test at 752h, IPF test at 753h, IPF test at 754h, IPF test at 755h, IPF test at 756h, IPF test at 757h, IPF test at 758h, IPF test at 759h, IPF test at 760h, IPF test at 761h, IPF test at 762h, IPF test at 763h, IPF test at 764h, IPF test at 765h, IPF test at 766h, IPF test at 767h, IPF test at 768h, IPF test at 769h, IPF test at 770h, IPF test at 771h, IPF test at 772h, IPF test at 773h, IPF test at 774h, IPF test at 775h, IPF test at 776h, IPF test at 777h, IPF test at 778h, IPF test at 779h, IPF test at 780h, IPF test at 781h, IPF test at 782h, IPF test at 783h, IPF test at 784h, IPF test at 785h, IPF test at 786h, IPF test at 787h, IPF test at 788h, IPF test at 789h, IPF test at 790h, IPF test at 791h, IPF test at 792h, IPF test at 793h, IPF test at 794h, IPF test at 795h, IPF test at 796h, IPF test at 797h, IPF test at 798h, IPF test at 799h, IPF test at 800h, IPF test at 801h, IPF test at 802h, IPF test at 803h, IPF test at 804h, IPF test at 805h, IPF test at 806h, IPF test at 807h, IPF test at 808h, IPF test at 809h, IPF test at 810h, IPF test at 811h, IPF test at 812h, IPF test at 813h, IPF test at 814h, IPF test at 815h, IPF test at 816h, IPF test at 817h, IPF test at 818h, IPF test at 819h, IPF test at 820h, IPF test at 821h, IPF test at 822h, IPF test at 823h, IPF test at 824h, IPF test at 825h, IPF test at 826h, IPF test at 827h, IPF test at 828h, IPF test at 829h, IPF test at 830h, IPF test at 831h, IPF test at 832h, IPF test at 833h, IPF test at 834h, IPF test at 835h, IPF test at 836h, IPF test at 837h, IPF test at 838h, IPF test at 839h, IPF test at 840h, IPF test at 841h, IPF test at 842h, IPF test at 843h, IPF test at 844h, IPF test at 845h, IPF test at 846h, IPF test at 847h, IPF test at 848h, IPF test at 849h, IPF test at 850h, IPF test at 851h, IPF test at 852h, IPF test at 853h, IPF test at 854h, IPF test at 855h, IPF test at 856h, IPF test at 857h, IPF test at 858h, IPF test at 859h, IPF test at 860h, IPF test at 861h, IPF test at 862h, IPF test at 863h, IPF test at 864h, IPF test at 865h, IPF test at 866h, IPF test at 867h, IPF test at 868h, IPF test at 869h, IPF test at 870h, IPF test at 871h, IPF test at 872h, IPF test at 873h, IPF test at 874h, IPF test at 875h, IPF test at 876h, IPF test at 877h, IPF test at 878h, IPF test at 879h, IPF test at 880h, IPF test at 881h, IPF test at 882h, IPF test at 883h, IPF test at 884h, IPF test at 885h, IPF test at 886h, IPF test at 887h, IPF test at 888h, IPF test at 889h, IPF test at 890h, IPF test at 891h, IPF test at 892h, IPF test at 893h, IPF test at 894h, IPF test at 895h, IPF test at 896h, IPF test at 897h, IPF test at 898h, IPF test at 899h, IPF test at 900h, IPF test at 901h, IPF test at 902h, IPF test at 903h, IPF test at 904h, IPF test at 905h, IPF test at 906h, IPF test at 907h, IPF test at 908h, IPF test at 909h, IPF test at 910h, IPF test at 911h, IP	

Table 3 Types of requests to the call center between April 2015 and August 2016

Type of request	No.	Percentages
Referral - Obst.	322	86.6
Referral - Neonatal	24	6.4
Referral - Medical	16	4.3
Expert - Obst.	7	1.9
Expert - Neonatal	1	0.5
Ambulance request only	2	0.3

common reasons being prolonged labour, and pregnancy induced hypertension and its complications and postpartum haemorrhage. The most common clinical reasons for newborn referral were birth asphyxia (58.3%) and prematurity (16.7%).

Response by referral receiving facilities

The overall response rate by receiving facilities was very good. Of 322 obstetric requests for bed space at a receiving facility, 260 beds were secured (Fig. 3), giving a success rate of 80.7%.

Almost all referrals were to hospitals with the majority (75%) going to the Greater Accra Regional Hospital, Ridge. (Table 5).

Hence, the overall total referral success rate over the period was 77.6, and 22.4% of patients that needed referral could not be referred because there was no bed available in almost all the major referral facilities called. Sometimes, when the call center was unsuccessful in securing a bed for the client and the case was critical; staff

Table 4 Reasons for obstetric referrals, showing frequency of occurrence in percentages

Reason for obstetric referral	No.	Percentage
Prolonged labour	81	25.1
PIH and Complications	56	17.4
PPH	21	6.5
APH	19	5.9
Abnormal presentation	18	5.6
Foetal distress	18	5.6
Delayed 2nd stage	17	5.3
Prev. C/S	15	4.7
CPD	9	2.8
Big abdomen	9	2.8
Meconium stained liquor	7	2.2
PROM	6	1.9
Retained placenta	5	1.5
Twin gestation	5	1.5
Others	36	11.2

members were still told to send their patients to the receiving facility while a solution was negotiated to save critical time. On arrival, the call center staff communicated directly with the staff at the receiving facility to admit the patient.

The call center could reach receiving facilities at the first attempt in 211 cases representing 63.6% of cases. In a small number of cases (1.2%), it took up to six attempts to reach a referral facility (Fig. 4).

National Ambulance Services

The call center received a lot of support from the National Ambulance Services (NAS). The NAS was able to provide an ambulance for 85 patients out of the 139 requests for ambulance services (61.2% success rate). For the nearly 39% of patients that the NAS was not able to serve, reasons given by the NAS and documented by the call center personnel included lack of fuel, the ambulance on other assignments or the ambulance undergoing servicing. Some of the health facilities made arrangements for their own ambulance, and therefore did not need the services of the call center to reach the NAS.

Phase two: post MTN (September 2016 – December 2017)

Types of request

Due to the withdrawal of services by the telecommunication company MTN, only the referral platform was operational from September 2016. A total of 390 calls were made to the center from September 2016 to December 2017. All the calls were for referral purposes, made up of medical emergencies (50.5%), obstetrics and gynaecological emergencies (30.3%), paediatric emergencies (8.7%), surgical emergencies (6.7%) and requests for ambulance services (3.8%).

Facilities calling and successes

Most calls came from primary level facilities (district hospitals and polyclinics) to other primary level facilities, secondary or tertiary facilities with the required expertise to manage the cases. (Fig. 5). Of the 92 requests for ambulance services, 71 were served, giving a success rate of 77.2%. It must be emphasized that the call center run side-by-side with the referral WhatsApp platform operated and coordinated by another organization.

Response by referral receiving facilities

There were 390 requests for beds of which 267 (68.5%) were honoured. There was no indication of whether patient was received or not for six referrals. One patient died before arrangement for referral could be completed. Of the 267 patients served with a bed through the call center, receiving facility was not indicated against 16 of them. Of the remaining 250 patients, as in phase 1, Ridge Regional

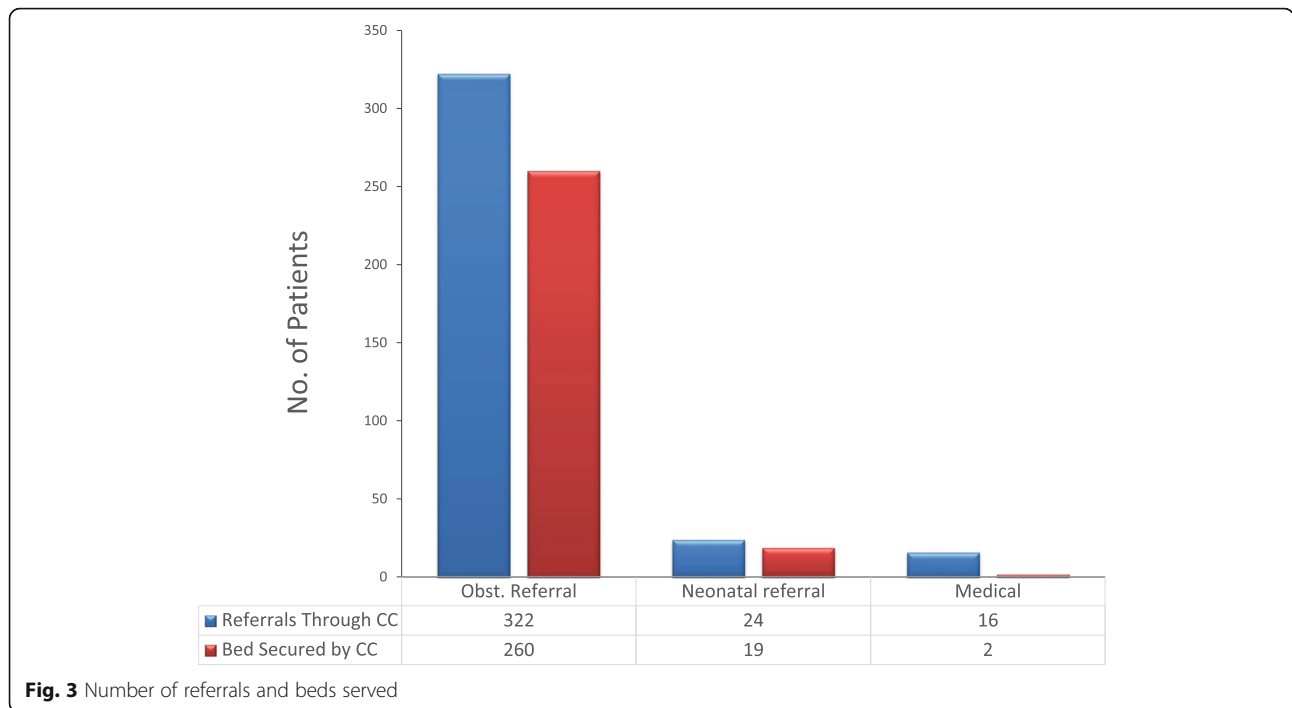


Fig. 3 Number of referrals and beds served

Hospital received 40.4% of the case forming the majority (Fig. 6). About 31.5% of referrals could not get a bed (receiving facility) because all the referral facilities contacted by the center indicated their beds were full.

Over the 33-month period that the data was analyzed, the total number of calls per month ranged from 5 to 54, with an average number of 23 calls per month. Much of the low average was driven by a severe drop in the number of calls per month between the months of August 2015 and November 2016 (Fig. 7).

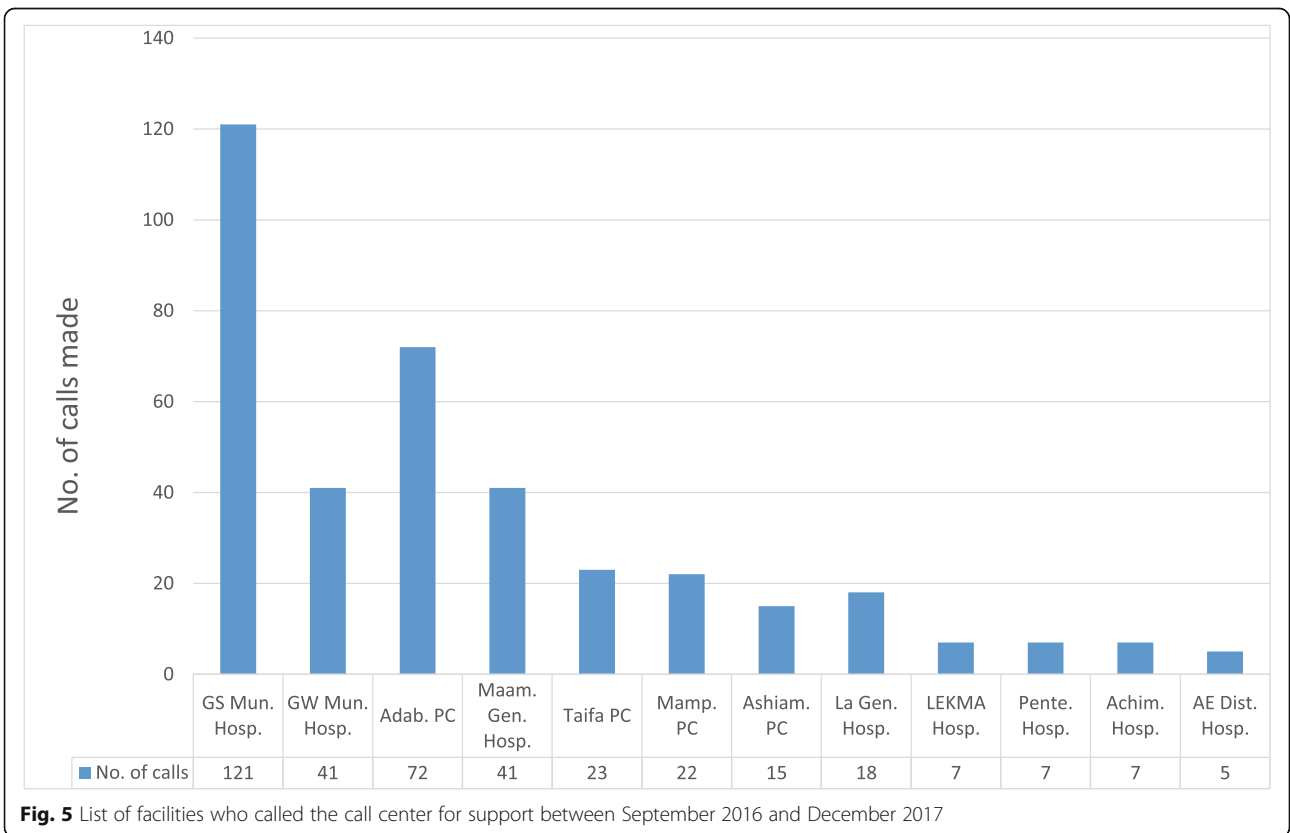
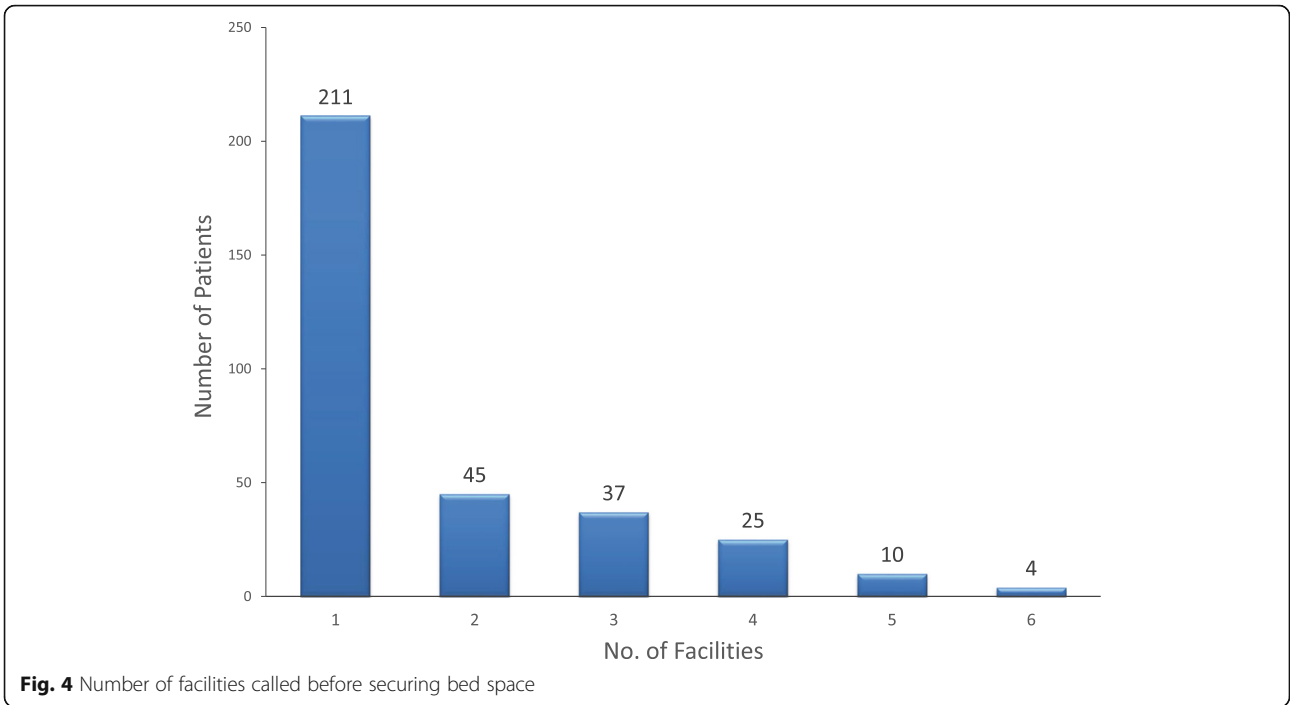
Discussion

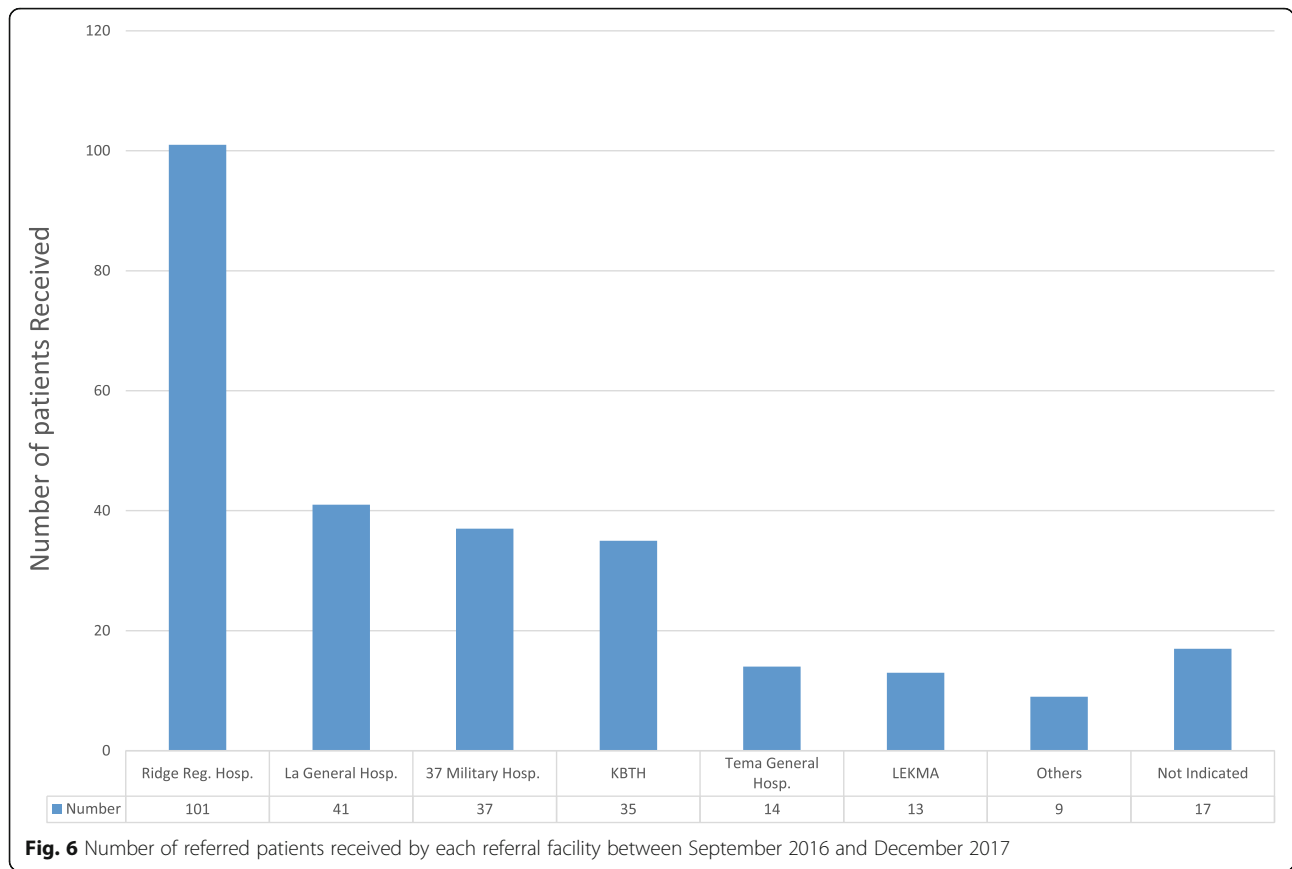
This ultimate aim of the call center intervention whose process or intermediate outcomes are analyzed and presented in this paper is to reduce referral delays and also to improve quality of care for referred mothers and

newborns. Delays in identifying and reaching the appropriate facility and delays in receiving of quality care once the woman reaches the facility remain major contributing causes of maternal morbidity and mortality in low and middle income countries since they were described over two decades ago [4]. The call center intervention was designed to help address delays in decision making as well as identifying a health facility for patients needed emergency specialist care and transferring them promptly. This was by the call center helping to identify quickly a facility with the required expertise ready to receive the emergency, and facilitating the transport of the patient to that facility. The difficulties in this area in Ghana and the tragic consequences have attracted wide spread attention from the public and parliament and has acquired the name “no bed syndrome” (e.g. <https://www.graphic.com.gh/features/opinion/no-bed-syndrome-a-telling-phenomenon-of-ghana-s-health-care.html>; <https://www.gbcghana.com/1.11658719>. Accessed 18–6-20) to describe the situation of referred patients moving from one health facility to another in a private vehicle, taxi or ambulance, looking for a facility with the required expertise and/or bed availability to manage their condition. The call center intervention was also designed in part to address delay in receiving quality care on reaching a health facility. Health facilities agreeing to receive an emergency referral where pre-informed through the call center system, and so better prepared to receive patients and address emergency needs. This reduced instances where emergencies had to queue to be attended to because facilities were unprepared, in terms of human resource and logistics to receive those emergencies.

Table 5 Patients received by referral facilities during phase 1

Receiving facilities	No. received	Percentage
Ridge Regional Hospital (GARH)	211	75
La General Hospital (LGH)	22	7.8
37 Military Hospital	19	6.8
Korle Bu Teaching Hospital (KBTH)	16	5.7
LEKMA Hosp.	5	1.8
Achimota Hospital	2	0.7
Pentecost Hospital	1	0.4
Not indicated	5	1.8
	281	100





Referral systems and Clinical decision-making support systems are potentially important interventions for improving maternal and newborn health outcomes by reducing these types of delays. The current implementation research study has focused on developing, implementing and monitoring the operational effects and feasibility of an intervention that tries to improve the situation using a call center to provide expert advice and coordinate referrals. Additionally, the research has explored how to implement such an intervention with locally available resources in a resource constrained setting. Beyond the core research questions of analyzing the process indicators of call center functioning the fact that this intervention and its monitoring and evaluation have been done almost entirely with such funding as could be mobilized locally and very little to no external funding is in itself learning about the challenges of research and innovation in a resource constrained context. Despite the resource challenges that never completely resolved the work was carried with modification and improvisation as a response to the resource constraints out because the intervention was a strong felt need in context. There can be incredible complexities involved in setting up and monitoring what may appear ‘a simple intervention’ in a low resourced country or context. This paper is therefore as much about the call center as it is

about the challenges of research and innovation in an LMIC context with limited government and almost no donor funding. This includes adapting intervention design and monitoring and evaluation methods to the resources available rather than giving up because the desired ideal is not possible. The lessons from the intervention and its monitoring and evaluation as well as carrying out research and innovation under resource constraints are of relevance not only to Ghana but to other low- and middle-income countries.

The findings of study suggest that the call center intervention that has been developed in the Greater Accra Region with the frontline health workers and managers and in response to their felt needs is doable and worth continued piloting, monitoring and evaluation to document its impact is on maternal and newborn health outcomes. The study has also clearly shown that there are several health system and contextual challenges that need to be addressed concurrently to effectively scale up and sustain the intervention and document its impact on maternal and newborn health outcomes in the medium to long term.

Firstly, there was the challenge of the limited number of receiving facilities and inadequate beds in relation to need that caused delays in referrals. This “No bed” syndrome is a long standing problem in the health sector in

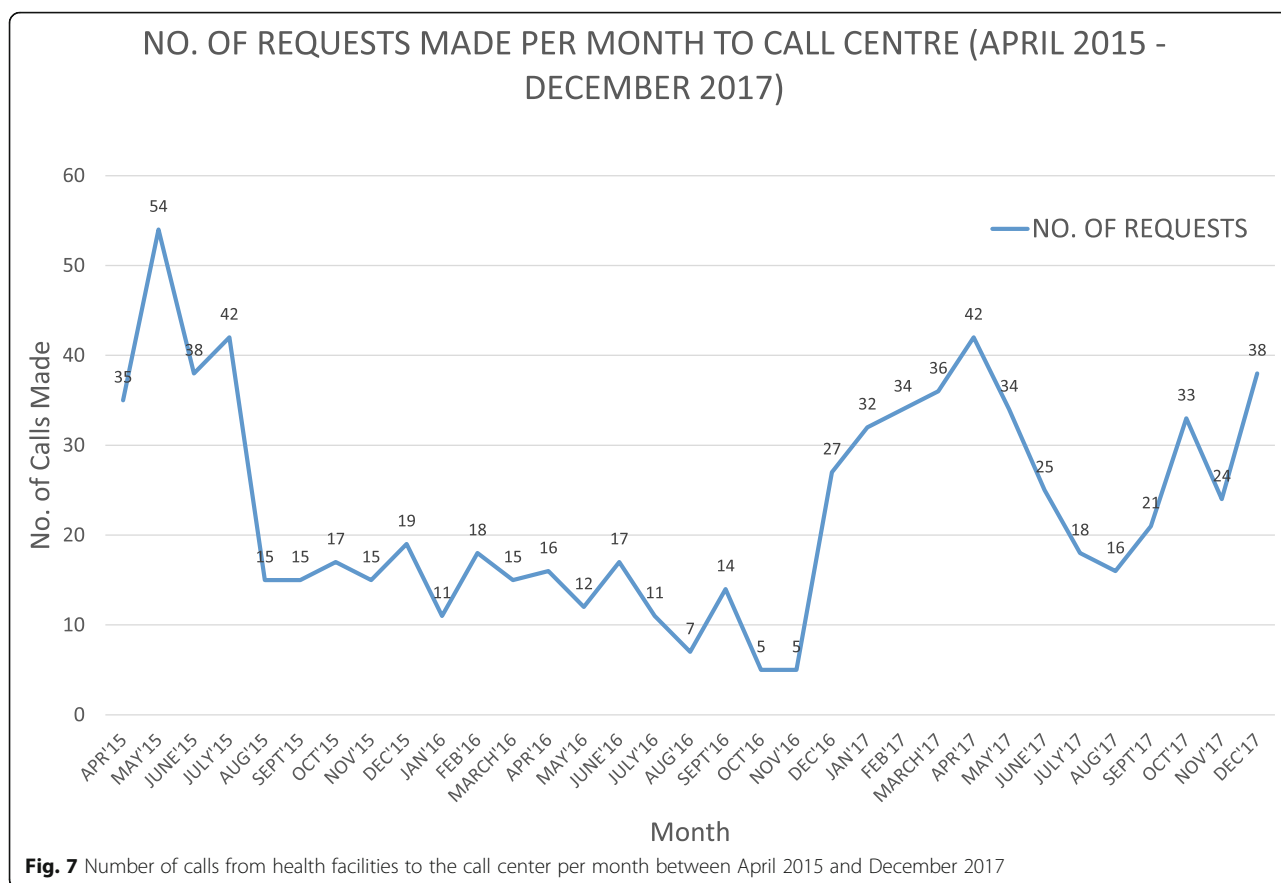


Fig. 7 Number of calls from health facilities to the call center per month between April 2015 and December 2017

the Greater Accra region [7–9]. The region has the fastest population growth in the country due to migration in and its infrastructure lags behind the population needs. The call center helped to coordinate referrals and potentially minimized referral delays but could not completely eliminate them partly because of this challenge. The “no bed” syndrome was responsible for majority of unsuccessful referrals. Providing adequate referral infrastructural capacity and human resource for maternal and neonatal health referrals is an urgent need that has to be tackled if the unfinished MDG 4 and 5 agenda which has now become part of the SDG are not to remain unfinished.

Secondly even where a referral hospital had beds available there was sometimes a problem of a lack of skilled staff in the night to attend to emergencies because of the challenge of inadequate human resource numbers as well as skill mix in the region. Despite the coping strategies put in place by facilities [10, 11], the problem persists because there is an absolute shortage. Since patient loads are lower at night, one such coping strategy is that skilled staff are preferentially put on the heavy day shifts. However, it means that most health facilities in the GAR do not have the required skilled personnel in the night needed to manage some of the maternal and newborn

health complications that turn up then, even when there are beds to admit the patient. Some of the referrals made by the referring facilities could have been avoided if frontline maternal and neonatal service providers were better skilled. Capacity development programs for emergency obstetric and neonatal care service providers especially at the primary health facilities could reduce the burden on any call center and also on referral beds.

Thirdly there was sometimes a lack of the needed equipment, tools and supplies as well as finances for the referral facilities to perform optimally. Some staff who had been dedicated as focal persons by their facilities to provide regular updates on bed state for maternal and newborn care in their facilities did not have dedicated phones for this activity. Effectively they had to use their own phones and pay for the cost of any calls. Thus, providing regular updates on bed state to the call center presented a huge challenge for them. Also, the call center services provided by the expert panel members were additional task to their regular work, meaning extra hours of work. However, given the funding constraints it was not possible to provide any remuneration for overtime as recognition of this added duty.

Fourthly and possibly related to the demotivation provided by some of the challenges outlined above,

sometimes the response and support from some of the referral facilities was poor. Sometimes, calls to referral facilities were not answered or phones were turned off at the receiving end. Also, in some cases the referring facilities placed a call for help through the follow-up officers' phone number instead of the triage phone number. This potentially delayed response times by making the routing more circuitous.

The low call volumes recorded during the latter part of 2015 was in part related to the onset of a nation-wide medical doctors' strike in July 2015, which lasted through to September 2015. Even after the strike ended, the underutilization pattern continued through till December 2016 when the center started operating 24 h. Another factor that probably accounted for some of the reduction in calls to the center even after the doctors strike ended was the introduction of other interventions by other partners in health development. Specifically, there was the introduction of a WhatsApp-based platform to facilitate referrals and expert advice for frontline health workers dedicated to maternal health services in early 2016. Although it covered just 50% of facilities, its ease of access meant most frontline personnel enrolled onto this platform. Thus, a number of maternal and newborn related cases which would have been routed through the call center was now managed over the WhatsApp based platform, significantly reducing call loads to the call center. This however demonstrated the negative impact of multiple independent unintegrated initiatives during the implementation and evaluation of impact of new interventions.

The private telecommunication company providing the IT platform in the first 17 months of operation of the Center had a Customer Care and Monitoring Software that tracked where calls are coming from, who was receiving the calls, time call came in among other important information. However, this software was not free and the Call Center was unable to raise enough money to purchase this tool. All the documentation, which was essential for monitoring and evaluation, therefore had to be manual. This introduced extra workload for the staff.

A major challenge the call center faced was finding sustainable ways to finance the recurrent costs of the call center such as the operative and maintenance cost, and the cost of running regular stakeholder meetings on the call center. This work has shown that it is possible to mobilize funds locally for an intervention of this nature. However, the resource constrained context remains a challenge that limits how much can be mobilized and requires constant creativity and adaptation. This constraint sometimes meant the call center had to manage in a less than optimal way. Incentives such as overtime allowances that were supposed to be provided for the expert panel members for the additional hours they spent to

provide services to patients if the intervention is to be sustained on a long term basis, could not be provided. Similarly a simple need to provide phones for the follow-up officers to improve their functioning could not be met. Countries like Ghana which are seen as transitioning or recently transitioned from being low income to lower middle income and needing less development assistance can be particularly challenged by not being "poor enough" and yet not "rich enough".

The problem with referral transportation and staff to accompany referrals is another major challenge. It is not a new one. Nkyerkyer in a study of peripartum referrals to the Korle-bu teaching hospital documented that as much as 72% of the referrals travelled to the hospital by public or private transport and 54% were not accompanied by any staff [5]. In a more recent study Atuoye et al. [12] also document the referral transportation challenge. Awoonor-Williams et al. [13] reported a study of pre post intervention audits of five (5) emergency obstetric and neonatal referral networks in the Upper East region of Ghana. Multiple micro-interventions selected by the facilities in the program included how to complete and use the partograph, posting and hiring new staff and drivers, infrastructure improvement, provision of additional equipment and supplies (including cell phones) and more intensive engagement with drivers and emergency transport preparation. Whether the referred woman was accompanied (and by whom) affected how quickly the referral got executed, the cost of referral and how stable her condition was upon arrival. There were also issues with whether the National Ambulance Service was available or referrals transportation had to be by taxi and motorbike. The availability of an ambulance was sometimes limited by the fact that the ambulances on duty were inadequate or may have been assigned to other emergencies, and so were not immediately available to assist the center.

In literature search to inform this study, we found very little on call center interventions to facilitate clinical decision making and referral for mothers and newborn in LMIC; but found several initiatives to improve communication between health facilities and emergency transportation with the aim of reducing transfer delays of both obstetric and neonatal cases in low and middle income countries. For example, in Southern Malawi, a repeater-based VHF communication system was installed in health centres for direct communication with district health offices to arrange for referral transport (Lunga and Ratsma, [14]). In India, the implementation of the JSY cash programme to enhance access to EmOC facilities, produced some unintended effects such as adverse birth outcomes (Chaturvedi et al. [15]). This problem was felt to be likely to have been caused by low quality of referral services and dearth of other amenities at the

EmOC and EmNC facilities such as basic supplies, drugs, equipment, and the inadequate number of surgery facilities as found in other settings (Cavallaro and Marchant, [16]; Fikree et al. [17]). In rural Burundi, a joint EmOC facility and car ambulance service was associated with an increased coverage of complicated obstetric cases and caesarean sections resulting in reduced maternal and new-born deaths (Tayler-Smith et al. [18]). In Malawi and Zambia, the use of emergency transport systems such as motorcycle ambulances, bicycle ambulances, boats, oxen and donkey carts, depending on the terrain, caused a significant reduction in referral delays (SurrIDGE et al. [19]; Bhopal et al. [20]; Hofman et al. [21]) coupled with high community acceptability, accessibility and value for ambulance services (SurrIDGE et al. [19]; Bhopal et al. [20]). Similar findings of enhanced access to, and the use of maternal and new-born health services; increased institutional deliveries; reduced maternal deaths due to the availability of free-of-charge 24-h ambulance services have been found in different settings including Uganda, Honduras, Sri Lanka, Sierra Leone, Malaysia, Nepal, South Africa (Prinja et al. [22]; Mucunguzi et al. [23]; Schoon, [24]; Murray and Pearson, [25]; Samai and Sengeh, [26]).

It will be important to link emergency transportation access to any call centre intervention for support decision making and facilitate and reduce referral delays in LMIC. The findings of challenges with emergency transportation in this study despite the fact that the Greater Accra Region is better served than the rest of the country, confirms this need for that a multi-team as well as multi-sectorial approach that includes interventions to improve emergency transportation and road access. Similar observations have been made in other LMIC e.g. [Essien e. Ifenne D., Sabitu K., Musa A., et al. 1997 International Journal of Gynecology and Obstetrics 59 supplement 2 S237-S244. Community Loan Funds and transport services for obstetric emergencies in Northern Nigeria].

This study was conducted in the Greater Accra Region of Ghana, which is 90% urban and relatively better served than much of the country. It is therefore open to the critique that perhaps the circumstances of the study setting are very different from the rest of Ghana and much of rural sub-Saharan Africa. However, the limited literature we found on referral interventions and experiences in Ghana suggest that the challenges and needs in other parts of Ghana may have much in common with the study setting. Afari et al. 2014 [6] in a qualitative study to understand local healthcare worker perspectives on cause of challenges in the referral of obstetric cases in Assin North, a rural district in the Eastern region of Ghana found that contextual factors such as roads and road security as well as transportation limited referral

systems. There were also challenges with inadequate care (stabilizing and monitoring the patient) during transportation between referral and receiving facility. Part of it was related to the use of non-ambulance transport that is not suitably equipped for emergency obstetric care. There were also communication barriers related to the fact that there were no standard systems for communication on emergency obstetric care so any communication is dependent on the initiative of the individual provider e.g. give personal phone numbers to patients, call ahead to receiving units, accompany patients. Related to the communication problems, lack of advance notice from referring health centers makes it more difficult for hospital staff to prepare adequately. Inadequate staff numbers and skills were sometimes also a problem e.g. no staff to accompany referred patients in critical condition, late recognition of danger signs and taking of appropriate action.

Additionally, despite the perception of its seeming “privilege”, the Greater Accra region is particularly challenged by the massive migration into the region and heavy urbanization (now over 90% urban) without corresponding increase in infrastructure, equipment, tools and supplies and human resources for health. As rural urban drifts continue and urbanization increases across Africa, attention needs to be paid to the potential challenges of urban health in low resource settings.

Although the call center was set up purposely to reduce the need for referrals, the low volumes of requests for expert advice (2.4% in phase 1) bring to the fore the lack of skilled personnel, lack of resources or lack of both in lower level facilities. This suggests the need for staffing, capacity building and resourcing of health facilities to manage for complicated medical conditions at lower levels of care. This is because most frontline workers considered the need to refer patients higher and above the need to seek for expert advice to manage patients in their facilities.

Limitations of the study

The design and piloting of the call center intervention within the real world constraints of limited resources and with a bottom up participatory approach has provided valuable insights about implementing a referral and decision making support call center despite the resources constraints of a low and middle income country. We know how and why the intervention works (or not) in context. We have however not evaluated its effectiveness in terms of its impact on maternal and newborn health outcomes. That will be important to do as the next stage of this effort. The lack of an electronic call recording, documentation and storage system prevented us from identifying calls which may have been missed

due to absence of center officers. This may have affected the validation of actual total number of calls received.

Conclusion

A call center to coordinate referrals and expert advice is a potential viable E-Health intervention to support improved Maternal and Newborn care, as well as other clinical emergencies in an LMIC. However, to achieve its full benefit, it needs to be implemented whilst concurrently addressing health systems challenges such as staffing, referral beds, emergency transportation and road access. It has been possible to mobilize some domestic resources to support the intervention. Advocacy and resources for maternal and new born survival needs to be tied to advocacy and resources for health systems strengthening. However adequate financing without external support remains a challenge in the resource constrained context of an LMIC. In a country like Ghana which is now classified as a lower middle income country and is in the process of transitioning to “Ghana beyond AID”, it is critical to invest more attention to issues of how to make support research to help identify financially sustainable, potentially lifesaving innovations and interventions.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12884-020-03534-2>.

Additional file 1: Supplementary 1. GAR/GHS Emergency Referral and Coordination Centre

Abbreviations

IGF: Internally Generated Funds; LMIC: Low- and Middle-Income Country; MDGs: Millennium Development Goals; MNH: Maternal and Newborn Health; NAS: National Ambulance service; RHD: Regional Health Directorate.

Acknowledgements

We thank all the staff of Ghana Health Service Greater Accra, the Regional Health Directorate and the officers manning the regional call center for their dedication and support. We also thank Ms. Philomena Anarkwah of the Greater Accra Regional Call Center for her secretarial support, as well as all senior managers of the Greater Accra Regional Health Directorate and National ambulance Service (Greater Accra office) for their technical assistance during implementation.

Authors' contributions

EOM participated in design of the study and its implementation, analysis of the findings and drafting of the manuscript. LAV participated in design of the study and drafting of the manuscript. IAA participated in the design and implementation of the study, analysis of the findings and drafting of the manuscript. EF participated in the implementation of the intervention and analysis of the data from the call center. MZ provided technical direction in the write-up and helped draft the manuscript. All authors contributed to the conceptualization, read and approved the final manuscript.

Funding

The study benefited from funding from the Greater Accra Regional Health Directorate and the Vrije University of Amsterdam Athena Center. The funding went into the set-up of the call center, training of officers and running of the center. This publication has been supported by the IDRC Canada through funding to the Consortium for Mothers, Children, Adolescents and

Health Policy and Systems in West and Central Africa (COMCAHPSS). Grant ID# 108237-001.

Availability of data and materials

The study received approval from the Regional Health Directorate, who are the owners of both the call center and data generated from the call center. The data that supports the findings of this study is available from the corresponding author with the permission of the Greater Accra Regional Director of Health Services, Ghana upon reasonable request. The call center is overseen by the Greater Accra Regional Health Directorate, and the data generated is part of routine documentation at the call center on a day to day basis. Being data from services provided to clients and health facilities, they are not publicly available.

Ethics approval and consent to participate

Ethical approval was received from the Ghana Health Service Ethics Review Committee, ID No. GHS-ERC: 06/09/14. An ethics statement or consent of participants was not required for this work since mainly administrative data was analyzed. Administrative permission was obtained from the Director of the Greater Accra Regional Health Directorate to access and use the data for research. The data used in this study was however not anonymised before its use.

Consent for publication

Not Applicable.

Competing interests

No authors have any competing interests to declare.

Author details

¹Ghana Health Service, La General Hospital, PMB, La, Greater Accra Region, Accra, Ghana. ²Ghana Health Service, Research and Development Division, Dodowa Health Research Center, P.O. Box DD1, Dodowa, Ghana. ³Athena Institute, Vrije University of Amsterdam, Amsterdam, Netherlands. ⁴Ghana Health Service, Greater Accra Regional Health Directorate, Accra, Ghana.

Received: 9 April 2019 Accepted: 29 December 2020

Published online: 13 January 2021

References

1. Ghana Statistical Service, Ghana Health Service, International ICF 2015. Ghana Demographic and Health Survey 2014 [Internet]. Rockville, Maryland USA; 2015 [cited 2016 Apr 5]. Available from: <https://dhsprogram.com/pubs/pdf/FR307/FR307.pdf>.
2. Awoonor-Williams K, Borg J, Dakpallah G, et al. Independent Review Health Sector Programme of Work 2009: Ghana [Internet]. 2009 [cited 2016 Apr 5]. Available from: http://www.moh-ghana.org/UploadFiles/Publications/Ghana_Health_Sector_Review_2009_draft_final_230410100425103955120509054714.pdf.
3. Ghana Statistical Service. 2010 Population and Housing Census: National Analytical Report [Internet]. Ghana Statistical Service. 2013 [cited 2016 Apr 5]. Available from: http://www.statsghana.gov.gh/docfiles/2010phc/National_Analytical_Report.pdf.
4. Thaddeus S, Maine D. Too to walk : maternal mortality in. *Soc Sci Med*. 1994;38(8):1091–110.
5. Nkyekyer K. Peripartum referrals to Korle Bu teaching hospital, Ghana - a descriptive study. *Tropical Med Int Health*. 2000;5(11):811–7.
6. Afari H, Hirschhorn LR, Michaelis A, et al. Quality improvement in emergency obstetric referrals: qualitative study of provider perspectives in Assin North district, Ghana. *BMJ Open* [Internet]. 2014;4(5):e005052 Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4025473&tool=pmcviewer&rendertype=abstract>.
7. Oduro-Mensah E, Kwamie A, Antwi E, et al. Care Decision Making of Frontline Providers of Maternal and Newborn Health Services in the Greater Accra Region of Ghana. *PLoS One*. 2013;8(2).
8. Nwameme AU, Phillips JF, Adongo PB. Compliance with emergency obstetric care referrals among pregnant women in an urban informal settlement of Accra, Ghana. *Matern Child Health J* [Internet]. 2014; [cited 2016 mar 22];18(6):1403–12. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24178157>.

9. Tunçalp Ö, Hindin MJ, Adu-Bonsaffoh K, et al. Assessment of maternal near-miss and quality of care in a hospital-based study in Accra, Ghana. *Int J Gynaecol Obstet* [Internet]. 2013; [cited 2016 Mar 22];123(1):58–63. Available from: <http://www.sciencedirect.com/science/article/pii/S0020729213002774>.
10. Enweronu-Laryea CC, Nkyekyer K, Rodrigues OP. The impact of improved neonatal intensive care facilities on referral pattern and outcome at a teaching hospital in Ghana. *J Perinatol* [Internet] Nature Publishing Group. 2008; [cited 2016 Mar 22];28(8):561–5. Available from: <https://doi.org/10.1038/jp.2008.61>.
11. Tunçalp Ö, Hindin MJ, Adu-Bonsaffoh K, et al. Listening to Women's Voices: The Quality of Care of Women Experiencing Severe Maternal Morbidity, in Accra, Ghana. *PLoS One*. 2012;7(8).
12. Atuoye KN, Dixon J, Rishworth A, et al. Can she make it? Transportation barriers to accessing maternal and child health care services in rural Ghana. *BMC Health Serv Res* [Internet]. 2015;15(1):333 Available from: <http://www.biomedcentral.com/1472-6963/15/333>.
13. Awoonor-Williams JK, Bailey PE, Yeji F, et al. Conducting an audit to improve the facilitation of emergency maternal and newborn referral in northern Ghana. *Glob Public Health*. 2015;1(July):1–16.
14. Lunga K, Ratsma YE. Does the upgrading of the radio communications network in health facilities reduce the delay in the referral of obstetric emergencies in southern Malawi. *Malawi Med J*. 2007;19:1–8. <https://doi.org/10.4314/mmj.v19i1.10924>.
15. Chaturvedi S, Randive B, Diwan V, De Costa A. Quality of obstetric referral Services in India's JSY cash transfer Programme for institutional births: a study from Madhya Pradesh Province. *PLoS One*. 2014;9:e96773.
16. Cavallaro FL, Marchant TJ. Responsiveness of emergency obstetric care systems in low- and middle-income countries: a critical review of the "third delay". *Acta Obstet Gynecol Scand*. 2013;92:496–507. <https://doi.org/10.1111/aogs.12071>.
17. Fikree FF, Mir AM, Haq I. She may reach a facility but will still die! An analysis of quality of public sector maternal health services, district Multan, Pakistan. *J Pakistan Med Assoc*. 2006;56:156.
18. Tayler-Smith K, Zachariah R, Manzi M, Van den Boogaard W, Nyandwi G, Reid T, De Plecker E, Lambert V, Nicolai M, Goetghebuer S, Christiaens B, Ndelema B, Kabangu A, Manirampa J, Harries AD. An ambulance referral network improves access to emergency obstetric and neonatal care in a district of rural Burundi with high maternal mortality. *Tropical Med Int Health*. 2013;18:993–1001. <https://doi.org/10.1111/tmi.12121>.
19. SurrIDGE M, Green C, Kaluba D, Simfukwe V. Filling a gap in the referral system: linking communities to quality maternal health care via an emergency transport system in six districts of Zambia. *World Transp Policy Pract*. 2014;20.
20. Bhopal SS, Halpin SJ, Gerein N. Emergency obstetric referral in rural Sierra Leone: what can motorbike ambulances contribute? A mixed-methods study. *Matern Child Health J*. 2013;17:1038–43.
21. Hofman JJ, Dzimadzi C, Lungu K, Ratsma EY, Hussein J. Motorcycle ambulances for referral of obstetric emergencies in rural Malawi: do they reduce delay and what do they cost? *Int J Gynecol Obstet*. 2008;102:191–7. <https://doi.org/10.1016/j.ijgo.2008.04.001>.
22. Prinja S, Bahuguna P, Lakshmi PVM, Mokashi T, Aggarwal AK, Kaur M, Reddy KR, Kumar R. Evaluation of Publicly Financed and Privately Delivered Model of Emergency Referral Services for Maternal and Child Health Care in India. *PLoS One*. 2014;9. <https://doi.org/10.1371/journal.pone.0109911>.
23. Mucunguzi S, Wamani H, Lochoro P, Tylleskar T. Effects of improved access to transportation on emergency obstetric care outcomes in Uganda. *Afr J Reprod Health*. 2014;18:87–94. <https://doi.org/10.4314/ajrh.v18i3>.
24. Schoon MG. Impact of inter-facility transport on maternal mortality in the Free State Province. *SAMJ*. 2013;103:534–6.
25. Murray SF, Pearson SC. Maternity referral Systems in Developing Countries: current knowledge and future research needs. *Soc Sci Med*. 2006;62:2205–15.
26. Samai O, Sengeh P. Facilitating emergency obstetric care through transportation and communication, Bo, Sierra Leone. *Int J Gynecol Obstet*. 1997;59:5157–64. [https://doi.org/10.1016/S0020-7292\(97\)00161-6](https://doi.org/10.1016/S0020-7292(97)00161-6).

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

