The Availability of Emergency Obstetric Care in Birthing Centres in Rural Nepal: A Cross‑sectional Survey

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Introduction

Maternal and neonatal mortality are major public health problems worldwide as well as in Nepal. Despite substantial progress in reducing the Maternal Mortality Ratio (MMR) in Nepal from 539 to 239 maternal deaths per 100,000 between 1996 and 2016 (Ministry of Health et al. 2017; Pradhan et al. 1997), the MMR was the second highest in South-East Asia after Myanmar (WHO 2019). The neonatal mortality rate which was stagnant at 33 deaths per 1,000 live births for almost a decade (2001-2010) (Ministry of Health and Population et al. 2012, 2007) had declined to 21 deaths per 1,000 live births in 2016 (Ministry of Health et al. 2017).

The availability of Emergency Obstetric Care (EmOC) service is essential for increasing access to quality obstetric and neonatal care (Mkoka et al. 2014), increasing utilisation of maternal care services and institutional delivery (Rana et al. 2007), and ultimately reducing maternal and neonatal deaths (WHO et al. 2009). The availability of EmOC also indicates health system readiness to manage pregnancy and childbirth complications (Paxton et al. 2006; Travis et al. 2004). It has been estimated that with EmOC in place, up to 60% of maternal deaths and 85% of intrapartum-related neonatal deaths could be averted per year (Lawn et al. 2009).

Availability of emergency obstetric care

The Government of Nepal is continuing to expand the availability and access to EmOC through public and private health facilities as mandated strongly by policies and strategies (Ministry of Health 2017, 2016b; Family Health Division 2006, 2002). The availability of EmOC demands a skilled birth attendant (SBA) and a provision of seven 'signal functions' for Basic EmOC (BEmOC): (1) administration of parenteral antibiotics; (2) administration of uterotonic drugs; (3) administration of parenteral anticonvulsants for pre-eclampsia and eclampsia; (4) manual removal of the placenta; (5) removal of retained products; (6) performing assisted vaginal delivery; and (7) basic neonatal resuscitation while Comprehensive EmOC (CEmOC) cover all seven BEmOC services plus (8) the ability to do a caesarean section; and (9) blood transfusion (WHO et al. 2009).

As such, health post (HP) and primary health care centre (PHCC) are strengthened to provide 24/7 delivery services and hospitals to provide CEmOC services in all 77 districts of Nepal. As a result, 2,101 (43%) HPs and 188 (90%) PHCCs were providing services regularly and a CEmOC site was established in 72 districts (but only 60 were functional) in 2018 (Ministry of Health and Population 2019). Nevertheless, nationally the percentage of EmOC met need was only 38% in 2018 (Ministry of Health and Population 2019). The government’s safe motherhood and neonatal health long-term plan (2006-2017) was to have delivery services in 70% of HPs, BEmOC services in 80% of PHCCs, and CEmOC service in 60 districts by 2017 (Family Health Division 2006).

Very few studies have described the availability of human resources, medicines, and equipment to provide EmOC services in Nepal (Ministry of Health et al. 2017; Pradhan et al. 2010). Studies that have reported on the readiness of health facilities have focused on district-

level hospitals that provide CEmOC services only (Devkota et al. 2011) or limited to community-based birthing centres (without BEmOC and CEmOC) (Family Health Division 2014).

Currently, expansion and quality improvement of maternal and neonatal health service delivery at remote areas are being tested in Taplejung district (Ministry of Health 2016a). However, relatively little is known regarding the situation and readiness of health facilities to provide EmOC locally. Efforts to scale up maternal health services in this remote district and achieve the related Sustainable Development Goals (SDGs) have drawn attention to the need for evidence about service availability and readiness of birthing centres. Hence, our study aims to assess what birthing centres exist and how ready these are to provide EmOC services in Taplejung District.

Methods

Study area and context

The study was conducted in Taplejung; one of the remote mountainous districts in eastern Nepal. In 2016, the total number of women of reproductive age (15-49 years) was 37,965, the expected pregnancies and live births were 3,478 and 2,950 respectively (Ministry of Health 2016a). There were 62 health facilities (excluding private pharmacies and clinics) providing maternal and newborn care services at the time of the survey. Of these, 61 were public health facilities (one district hospital, two PHCCs, 50 HPs and eight community health units) and one was a private hospital.

According to the district health system, there is a provision of seven auxiliary nurse midwives (ANMs) (four non-SBA, three SBA), two operation theatre trained nurses, one anaesthesia

doctor/assistant, two obstetrics/gynaecologists, two medical officers, and nine paramedics in a district hospital that provides CEmOC services. Paramedics in Nepal includes health assistant (HA), auxiliary health worker (AHW), senior auxiliary health worker (Sr. AHW), laboratory technologist/officer/technician/assistant, radiographer, and darkroom assistant. Similarly, in PHCCs there were four paramedics (one HA, two AHWs/Sr.AHW, one laboratory technician/assistant), four ANMs (two non-SBAs, two SBAs) and one medical officer. In HP, which is a lower level of healthcare facility in Nepalese health system, there were two ANMs (at least one SBA in a health facility providing a delivery service) and three paramedics (one HA, two AHWs/Sr.AHW).

Selection of the health facilities

The survey involved all 16 public health facilities providing delivery services in the district (Supplementary Figure S1). This included one district hospital (15 bedded) designated to provide CEmOC, two PHCCs designated to provide BEmOC and 13 health posts designated to provide normal delivery services.

Study design and data collection

A cross-sectional health facility survey was conducted in 2018 using three data collection methods. First, data enumerators visited 16 birthing centres, and collected data using a structured survey tool. We used the core Service Availability and Readiness Assessment (SARA) questionnaire; the validated tool that has been designed to assess and monitor the service availability and readiness of health facilities. (WHO 2015).

Pre-testing of the survey questionnaire was done in two birthing centres of a neighbouring district. Following the pre-testing (van Teijlingen and Hundley 2005), adjustments were

made to the questionnaire to account for the information gained, resulting in the standard core questionnaire adapted for the district. Two enumerators and one field supervisor were mobilised to collect the data. The data collectors and field supervisor received one-day training before data collection. Data collectors obtained written informed consent in the local language before collecting the data from each concerned facility in-charge or nurse.

Secondly, data collectors observed the essential items that allowed us to determine the availability and the condition of equipment, medicines and commodities for EmOC. Finally, we extracted data from the Health Management Information Systems (HMIS) register of the included health facilities to determine the utilisation of EmOC signal functions and other maternal and newborn care services.

The ethical review board of Nepal Health Research Council approved this study (Reg. No. 435/2017) in December 2017.

Data management and analysis

The data collected on the paper questionnaire were checked for accuracy, completeness and consistency before entering electronically into Census and Survey Processing System (CSPro) Version 6.3 (WHO 2015). The complete data set was later analysed using SPSS version 24.

Descriptive statistics were used to assess the availability of EmOC services measured across domains (staff and guidelines, equipment, diagnostics (only in District Hospital), and medicines and commodities). The availability of EmOC services was also measured by determining the number of health facilities that performed the complete set of required signal

functions (seven for BEmOC and nine for CEmOC) in the three-month period before the assessment. Any facility providing at least one of the seven signal functions was considered as partially functioning BEmOC. Readiness scores were equal to the sum of the means that were obtained for each tracer item in a domain, divided by the total number of items in the domain, and then multiplied by 100. Readiness scores were calculated using unweighted averages.

Results

Availability of key health workers

Figure 1 shows the number of health workers at the time of assessment against the minimum staffing requirements for EmOC services. At the time of the survey, there were 117 health workers in 16 health facilities. Paramedics represented the largest category of staff (n=43/36.8%). SBA trained nursing staff including auxiliary nurse midwives (ANMs) (n=33/28.2%) were the second largest cadre of health workers in the birthing centres. Six medical officers (5.1%) were available in the District Hospital and PHCCs only. Obstetricians (2.6%) and anaesthesia doctor/assistant (1.7%) were available only in the District Hospital (Figure 1). Noticeably, the number of health workers in each group surpassed the number of sanctioned posts except for paramedics.

Availability of EmOC signal functions

Only the District Hospital offered CEmOC services (Table 1). None of the PHCCs could provide all seven signal functions. All 13 HPs had carried out at least one of the seven signal functions in three months before assessment (partially performing BEmOC). While the most commonly performed EmOC signal functions in three months before assessment by the surveyed health facilities was an administration of uterotonic drugs (87.5%), the least

performed BEmOC signal function was an administration of parenteral anticonvulsants (12.5%). None of the HPs studied used parenteral anticonvulsants. Similarly, none of the PHCCs expected to provide seven signal functions of BEmOC performed manual removal of placenta or assisted vaginal delivery during three months preceding the assessment.

Reasons for not performing EmOC signal functions

Except for the District Hospital, other surveyed health facilities did not perform a caesarean section and blood transfusion solely because of not fulfilling the policy requiring a specific infrastructure and trained providers to manage complicated deliveries (Figure 2). Although the reasons for not performing other seven signal functions were mixed, lack of case/patient requiring signal functions was predominant.

Percentage of services utilisation in EmOC facilities

Overall, 62.7% (n=662) of all institutional births occurred in CEmOC facility in the fiscal year 2016/17 (Table 2). The percentage of SBA delivery was also higher in CEmOC facility 59.4% (538) compared to partially functioning BEmOC facilities 40.6% (368). However, partially functioning BEmOC facility had the highest percentage of first ANC visits 60.5% (617), fourth ANC visits 71.7%% (457) as per protocol (*National Medical Standard for Reproductive Health* Vol. II), pregnant women receiving Td2 vaccine 58.7% (535), iron and folic acid 58.1% (735) including women receiving de-worming tablets 56.8% (698).

A total of 94 obstetric complications were recorded at all surveyed health facilities; HP (20.2%), PHCCs (2.1%) and district hospital (77.7%). Postpartum haemorrhage (39.4%), pre-eclampsia/eclampsia (14.9%), puerperal sepsis (12.8%) and prolonged labour (12.8%) were the main obstetric complications (Table 2).

Availability of emergency obstetric care

Availability of selected essential equipment

Essential equipment for performing some EmOC functions was not available in all facilities (Table 3). Complete delivery packs, vacuum aspiration (MVA) kits, and blank partographs were equally available at 87.5% (14/16). Oxygen supply (18.8%) was the least common equipment in the surveyed health facilities. Overall, the availability of equipment varied depending on the type of health facility. Equipment was more frequently available in the District Hospital and PHCCs than in HPs.

Availability of selected essential medicines and commodities

Chlorhexidine, oxytocin, magnesium sulphate and intravenous solution with infusion set (without dextrose) were equally available at 87.5% (14/16) of health facilities on the day of the survey (Table 4). Gentamicin injection 31.3% (5/16) was least available in all health facilities offering EmOC included. While PHCCs lacked ampicillin injections, the district hospital was deficient in xylocaine, blood supply and other essential medicines (e.g., halothane, thiopental).

Obstetric service readiness in health facilities

The overall readiness score was 76.8% for providing BEmOC and the highest was for equipment (87.1%) and the lowest for staff and guidelines (51.3%) as shown in Figure 3. There was difference in the BEmOC readiness score by type of health facility. A higher-level health facility (District Hospital) had a higher readiness score than a lower-level health facility (HP), 95.8% versus 74.0%. Figure 4 shows the overall readiness score to provide CEmOC was 70.0% and highest for staff and guidelines (100.0%) and diagnostics (100.0%), and the lowest for medicines and commodities (44.4%).

Availability of emergency obstetric care

Geographic distribution of EmOC facilities

The distribution of EmOC services varied across the district. Only one available CEmOC facility was mainly concentrated in Phungling Municipality (district headquarter). Partially performing BEmOC facilities were mainly available in rural municipalities of South East and South West regions as shown in Supplementary Figure S1. All these facilities were located in hilly areas with an elevation ranging between 1,295 to 2,484 meters.

Discussion

This study provides detailed information on the availability of staff, equipment, medicines and commodities along with readiness of birthing centres to provide EmOC services in Taplejung District. The District Hospital provided nine signal functions of CEmOC for 129,767 people at the time of the study. Other fifteen were found to be partially functioning BEmOC facilities, as they did not provide all the seven signal functions. The WHO handbook on monitoring EmOC recommends the minimum of five EmOC facilities with at least one CEmOC per 500,000 population (WHO et al. 2009). According to the standard set by the guideline, our study has shown that overall the minimum acceptable level of EmOC services in Taplejung has not been met, although, District Hospital offers CEmOC.

The District Hospital, as a consequence was overcrowded with deliveries. The study found that in the fiscal year 2016/17, 62.7% of total institutional deliveries in the district took place in the District Hospital. This relatively higher percentage of women delivering in the District Hospital irrespective of a lower percentage of fourth ANC visits as per protocol (28.3%) than in partially functioning BEmOC (71.7%) has several explanations. First, it is important to note that this hospital handles most of the complicated cases referred from other health

facilities within the district. In addition, as other partially performing EmOC services were located mainly in the remote hilly areas, the pregnant women and their families due to remoteness and lack of comprehensive services including caesarean section may less prefer them (Anastasi et al. 2015; Bohren et al. 2014).

Most of the EmOC services in PHCCs are underutilised which could be linked to the lack of necessary facilities such as operating theatre to handle complicated cases despite the availability of a doctor. The low availability and readiness of EmOC services in HPs may encourage women to deliver at home without the assistance of SBA (Roro et al. 2014). There may also be an increased risk of bypassing local birth centres and delivering at urban health facilities (Karkee et al. 2015).

Unlike the studies conducted in Nepal and other LMICs (Low and Middle Income Countries), our study found that Taplejung District has good availability of key health personnel for providing EmOC services. It might be due to the determination of the leadership of District Health Office to fulfil the sanctioned posts through short-term contracted staff recruited by the regional health directorate, district health office, local governments, and non-governmental organisation. At the time of assessment, the number of SBAs, non-SBAs, ANMs and doctors surpassed the sanctioned post except for paramedics.

The overall readiness score to provide BEmOC in Taplejung (76.8%) was much higher than figures shown in other LMICs (Bintabara et al. 2019; Kanyangarara et al. 2018; Andriantsimietry et al. 2016). In Madagascar, district hospitals had a mean score of 60.4% and basic health centres had a 44.5% for BEmOC services in 2014 (Andriantsimietry et al. 2016). In Tanzania, the overall readiness score for BEmOC was 40.3% (Bintabara et al.

2019). A study that assessed the obstetric service readiness in 17 LMICs showed that the median percentage of facilities readiness to provide EmOC was 10% (Kanyangarara et al. 2018). However, it is important to note that there were discrepancies in the tracer items used in the domains.

A few HPs were performing assisted vaginal deliveries and manual removal of placenta but PHCCs were not because of lack of cases to perform these signal functions in the last three months in the PHCCs. The possible rational for no cases in PHCCS might be due to easy access to neighbouring district hospital and tertiary hospitals. The other reasons of unavailability of a case to perform signal functions may be the non-risk taking attitude of health workers. SBA trained nurse who are authorised to perform the signal functions independently can do so only after evaluating that a patient meets the criteria and patients with serious complications would eventually be referred to hospital. This means that health workers from health posts and PHCCs tend to refer pregnant women to a higher level of health care than handling the deliveries themselves for fear of maternal and neonatal complications is justifiable. Availability of suitably trained cadre of health workers and equipment in the birthing centres but their fear of maternal and neonatal complications and case referring attitude could be the subject of future study. It would be useful to know in the future study what kind of case the HPs, and PHCCs refer to the tertiary health care system.

Although our study indicates that lack of cases as the main reason for not performing EmOC services, unavailability of essential equipment and medicine also remained vital. The study found that essential equipment and medicines for performing some EmOC functions was either missing or not functional. For example, xylocaine was not available in a place where caesarean section was carried out in district hospital as it was stocked out on the day of the

survey. The health personnel interviewed explained that they periodically experienced stock-out of medicine and equipment needed for removal of retained products and performing assisted vaginal delivery including administration of parenteral antibiotics. The findings are consistent with evidence from studies conducted in India (Sabde et al. 2016), and Ethiopia (Ethiopian Public Health Institute et al. 2017).

Parenteral administration of anticonvulsants was the least performed signal functions which is consistent with the findings from Nepal (Ministry of Health et al. 2017), and other 17 LMICs (Kanyangarara et al. 2018). Similarly, the other signal functions least performed, i.e. removal of retained products by manual vacuum aspirations and assisted vaginal delivery (vacuum extraction) are similar to the findings of the study conducted in LMICs (MEASURE Evaluation PIMA 2016; Worku et al. 2013; Ameh et al. 2012) including Nepal (Ministry of Health et al. 2017).

Limitations

This study, which involved a survey of health facilities, observation of key items and extraction of data from health facility register, has some limitations. It is possible that staff might have been biased in providing information on the availability of the equipment, supplies and commodities to seek support and influence donor agencies working on the district. This could have affected the information on the availability, which was based on whether the equipment was available. It was to limit this response bias that we chose to observe the essential items and further categorised as observed, reported not seen and not available. To avoid information bias, the respondent of the survey was either facility in-charge or responsible staff member of maternal and newborn care services.

Availability of emergency obstetric care

The data on service utilisation was extracted from the health facility register, i.e. HMIS, held by the health facilities which is often criticised as being incomplete. It is, therefore, possible the use of the EmOC services to be exaggerated due to poor record keeping. Nevertheless, we attempted to reduce this uncertainty by liaising with the maternity ward in-charge so that she could confirm the validity of the records.

Since it was a cross-sectional study, the mere availability or unavailability of equipment, medicine and commodities at the time of survey may disguise situations when these items were generally available and were only missing at the time of the study and vice versa. In addition, we cannot report any cause and effect as the study provides only a snapshot of the availability and readiness of birthing centres in surveyed health facilities. The study does not include user behaviour as it is outside the remit of the study objective. Another limitation was that this study does not measure the quality of the services provided.

Conclusions

In Taplejung, EmOC services were below the minimum coverage level recommended by WHO and the essential items for performing some EmOC functions were either missing or not functional. There is a clear need that the Ministry of Health and Population need to upgrade the partially performing BEmOC facilities to fully functioning BEmOC services by improve supply chain of essential medicines and commodities, and emergency transport in all facilities providing delivery services. The National Health Training Centre needs to provide delivery and newborn care service guidelines to ensure that EmOC services are provided as per these national guidelines. Besides, the local level government needs to conduct subsequent periodic assessments to examine progress achieved. The future study needs to

focus on understanding geographic or financial barriers to care and exploring the reasons for underutilisation of EmOC services.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Tables

Table 1. Health facilities performing EmOC signal functions in three months prior to assessment.

Signal function	All facilities % (n = 16)	Type of health facility		
		HP % (n = 13)	PHCC % (n = 2)	DH % (n = 1)
BEmOC signal functions				
Administer parenteral antibiotics	37.5 (6)	23.1 (3)	100.0 (2)	100.0 (1)
Administer uterotonic drugs	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Administer parentral anticonvulsants	12.5 (2)	0.0 (0)	50.0 (1)	100.0 (1)
Perform manual removal of placenta	31.3 (5)	30.8 (4)	0.0 (0)	100.0 (1)
Perform removal of retained products	25.0 (4)	15.4 (2)	50.0 (1)	100.0 (1)
Perform assisted vaginal delivery	31.3 (5)	30.8 (4)	0.0 (0)	100.0 (1)
Perform newborn resuscitation	50.0 (8)	46.2 (6)	50.0 (1)	100.0 (1)
CEmOC signal functions				
Perform blood transfusion	6.3 (1)	0.0 (0)	0.0 (0)	100.0 (1)
Perform caesarean section	6.3 (1)	0.0 (0)	0.0 (0)	100.0 (1)

EmOC: emergency obstetric care; BEmOC: basic emergency obstetric care; CEmOC: comprehensive emergency obstetric care; HP: health post; PHCC: primary health care centre; DH: district hospital

Availability of emergency obstetric care

Table 2. Utilization of maternal and newborn health services in 16 health facilities in fiscal year 2016/17.

Service indicators	All facilities	Type of health facility		
		HP (%)	PHCC (%)	DH (%)
Number of first ANC visits as per protocol	1020	512 (50.2)	105 (10.3)	403 (39.5)
Number of fourth ANC visits as per protocol	637	391 (61.4)	66 (10.4)	180 (28.3)
Number of pregnant women who received Td2	912	491 (53.8)	44 (4.8)	377 (41.3)
Number of new pregnant women who received iron and folic acid (combined tablets)	1265	649 (51.3)	86 (6.8)	530 (41.9)
Number of women who received de-worming tablets	1228	610 (49.7)	88 (7.2)	530 (43.2)
Number of institutional deliveries	1056	340 (32.2)	54 (5.1)	662 (62.7)
Number of SBA delivery in facility or at home by facility staff	906	317 (35.0)	51 (5.6)	538 (59.4)
Complications seen				
Pre-eclampsia/eclampsia	14	1 (7.1)	0 (0.0)	13 (92.9)
Puerperal sepsis	12	1 (8.3)	0 (0.0)	11 (91.7)
Postpartum haemorrhage	37	4 (10.8)	1 (2.7)	32 (86.5)
Prolonged labour	12	4 (33.3)	0 (0.0)	8 (66.7)
Retained placenta	7	6 (85.7)	1 (14.3)	0 (0.0)
Ectopic pregnancy	9	0 (0.0)	0 (0.0)	9 (100.0)
Other	3	3 (100.0)	0 (0.0)	0 (0.0)

HP: health post; PHCC: primary health care centre; DH: district hospital; ANC: antenatal care; Td: tetanus diphtheria

Availability of emergency obstetric care

Table 3. Percentage distribution of selected equipment for EmOC in 16 health facilities

Equipment	All facilities % (n = 16)	Type of health facility		
		HP % (n = 13)	PHCC % (n = 2)	DH % (n = 1)
Emergency transport	43.8 (7)	38.5 (5)	50.0 (1)	100.0 (1)
Sterilization equipment	93.8 (15)	92.3 (12)	100.0 (2)	100.0 (1)
Examination light	81.3 (13)	76.9 (10)	100.0 (2)	100.0 (1)
Delivery pack	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Suction apparatus (mucus extractor)	31.3 (5)	23.1 (3)	50.0 (1)	100.0 (1)
Manual vacuum extractor	81.3 (13)	76.9 (10)	100.0 (2)	100.0 (1)
Vacuum aspiration or MVA kit	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Neonatal bag and mask	81.3 (13)	76.9 (10)	100.0 (2)	100.0 (1)
Delivery bed	100.0 (16)	100.0 (13)	100.0 (2)	100.0 (1)
Blank partographs	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Gloves	100.0 (16)	100.0 (13)	100.0 (2)	100.0 (1)
Infant weighing scale	100.0 (16)	100.0 (13)	100.0 (2)	100.0 (1)
Blood pressure apparatus	100.0 (16)	100.0 (13)	100.0 (2)	100.0 (1)
Soap and running water or alcohol based hand rub	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Resuscitation table with warmer	25.0 (4)	7.7 (1)	100.0 (2)	100.0 (1)
Oxygen supply	18.8 (3)	0.0 (0)	100.0 (2)	100.0 (1)
Incubator	n/a	n/a	n/a	0.0 (0)
Anaesthesia equipment	n/a	n/a	n/a	100.0 (1)
Spinal needle	n/a	n/a	n/a	100.0 (1)

HP: health post; PHCC: primary health care centre; DH: district hospital; MVA: manual vacuum aspiration: n/a: not applicable

Availability of emergency obstetric care

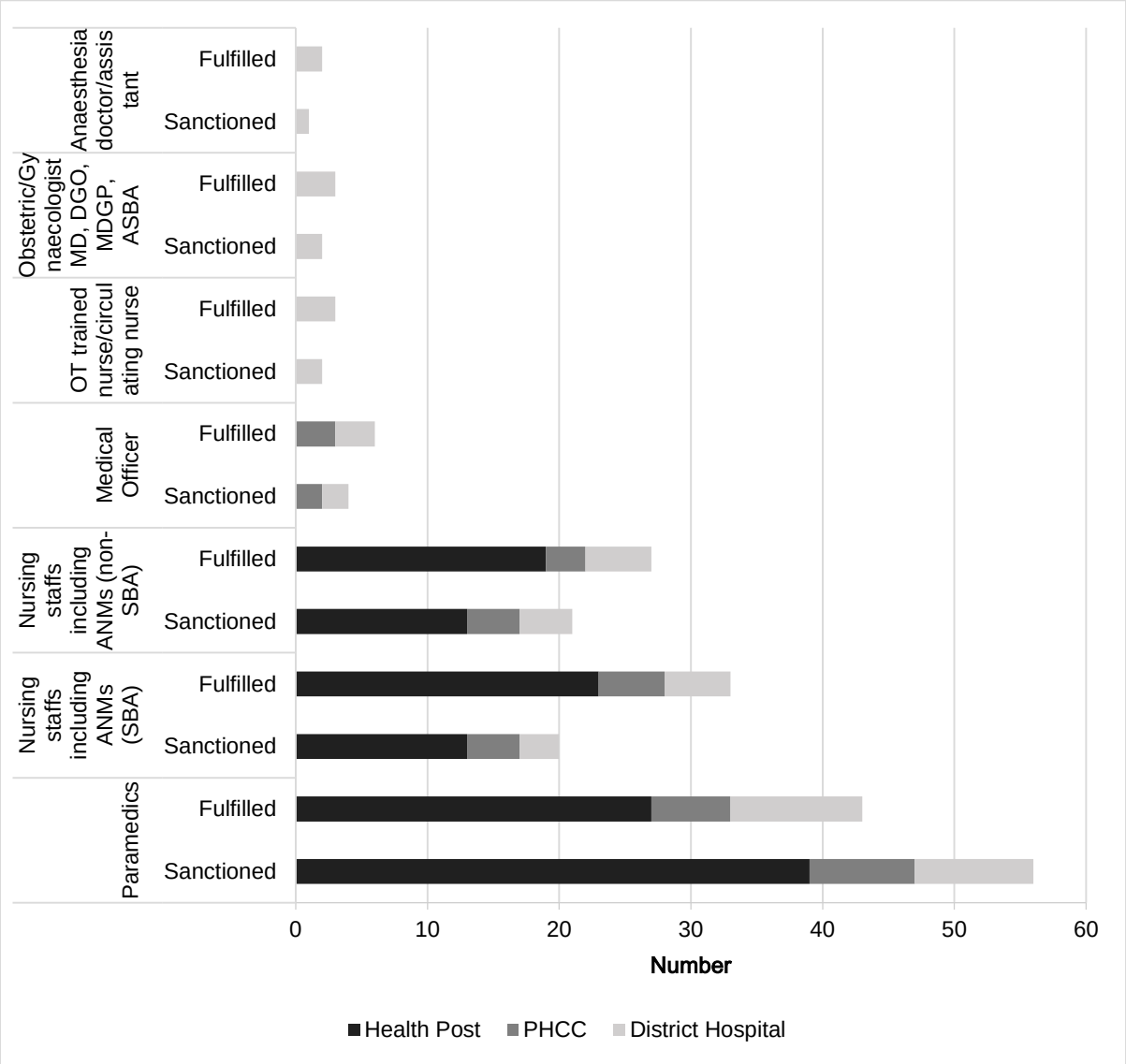
Table 4*. Percentage distribution of selected medicines and commodities for EmOC in 16 health facilities

Medicines and commodities	All facilities % (n = 16)	Type of health facility		
		HP % (n = 13)	PHCC % (n = 2)	DH % (n = 1)
Skin disinfectant (Chlorhexidine)	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Inj Oxytocin	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Inj Ampicillin	43.8 (7)	46.2 (6)	0.0 (0)	100.0 (1)
Inj Gentamicin	31.3 (5)	23.1 (3)	50.0 (1)	100.0 (1)
Inj Magnesium Sulphate	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Intravenous solution with infusion set	87.5 (14)	84.6 (11)	100.0 (2)	100.0 (1)
Inj Xylocaine	37.5 (6)	38.5 (5)	50.0 (1)	0.0 (0)
Inj Epinephrine	37.5 (6)	30.8 (4)	50.0 (1)	100.0 (1)
Blood supply sufficiency	n/a	n/a	n/a	0.0 (0)
Blood supply safety	n/a	n/a	n/a	100.0 (1)
Halothane (inhalation)	n/a	n/a	n/a	0.0 (0)
Atropine (injectable)	n/a	n/a	n/a	100.0 (1)
Thiopental (powder)	n/a	n/a	n/a	0.0 (0)
Suxamethonium bromide (powder)	n/a	n/a	n/a	0.0 (0)
Inj Ketamines	n/a	n/a	n/a	100.0 (1)

HP: health post; PHCC: primary health care centre; DH: district hospital; Inj: injection; n/a: not applicable

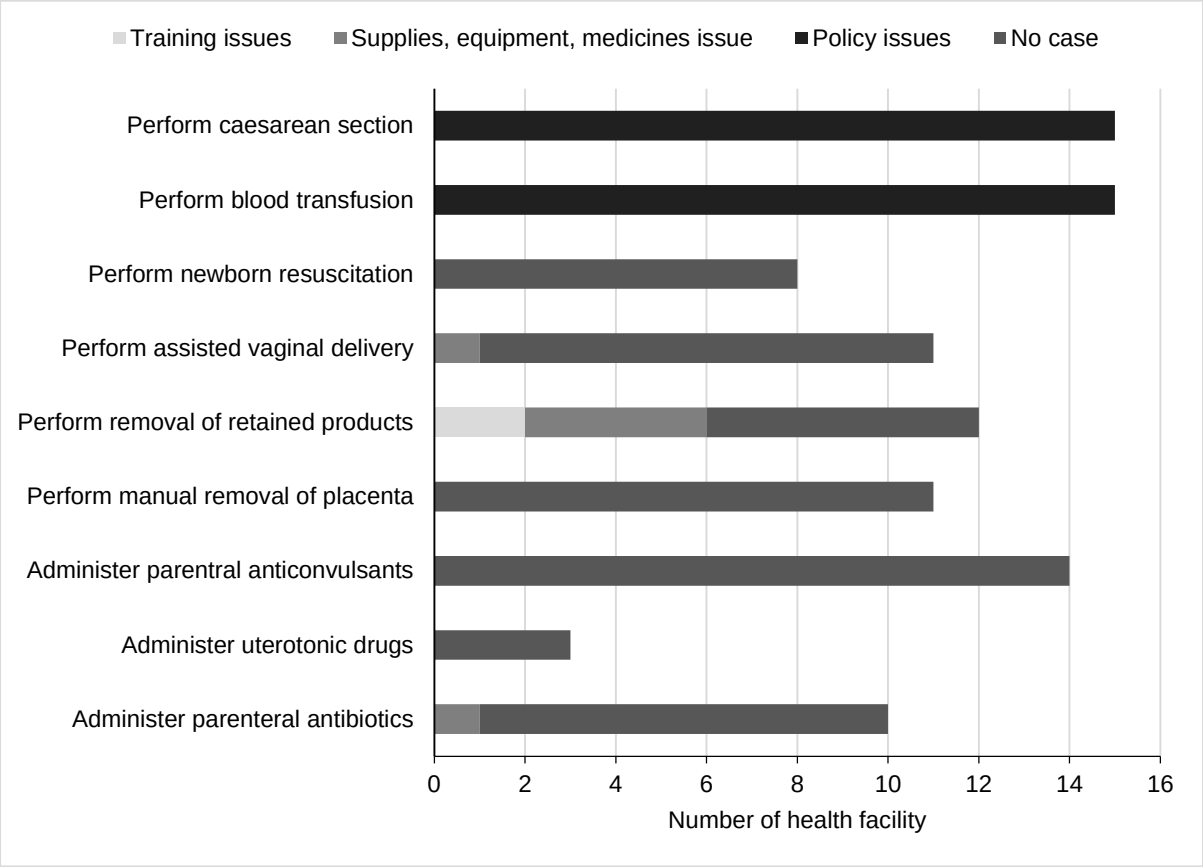
Figures

Figure 1 top



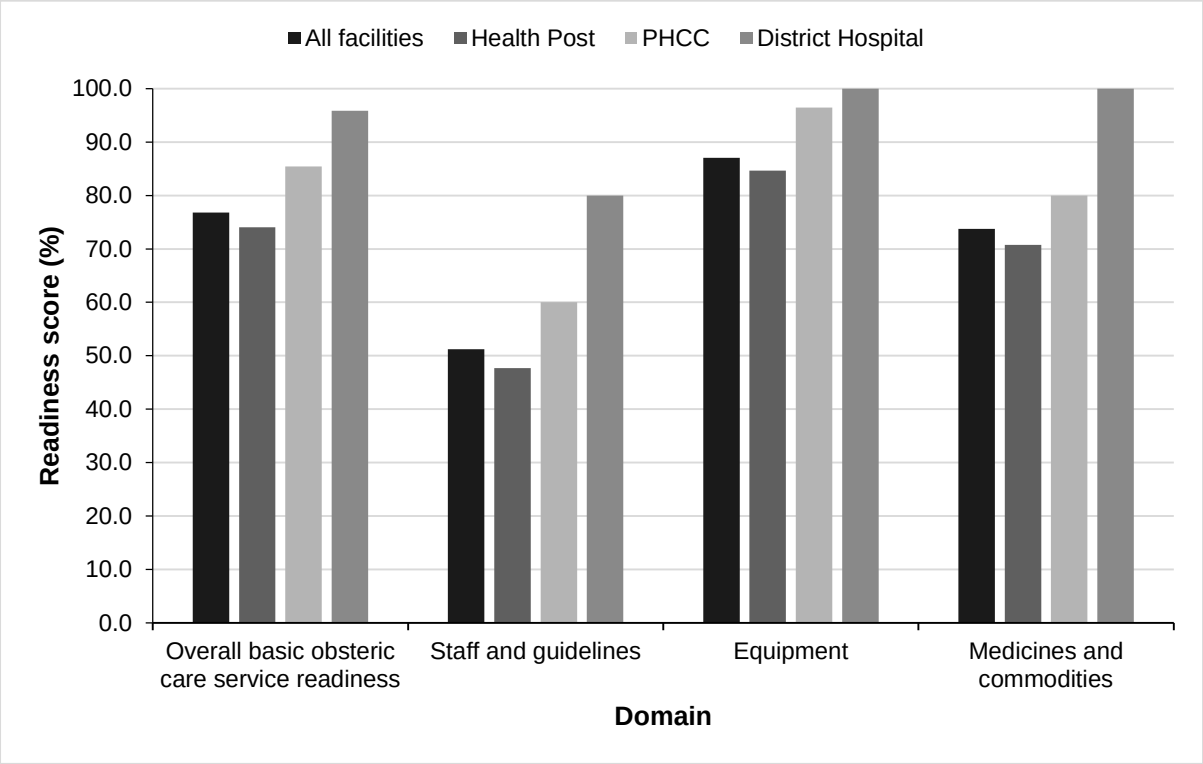
Availability of emergency obstetric care

Figure 2 top



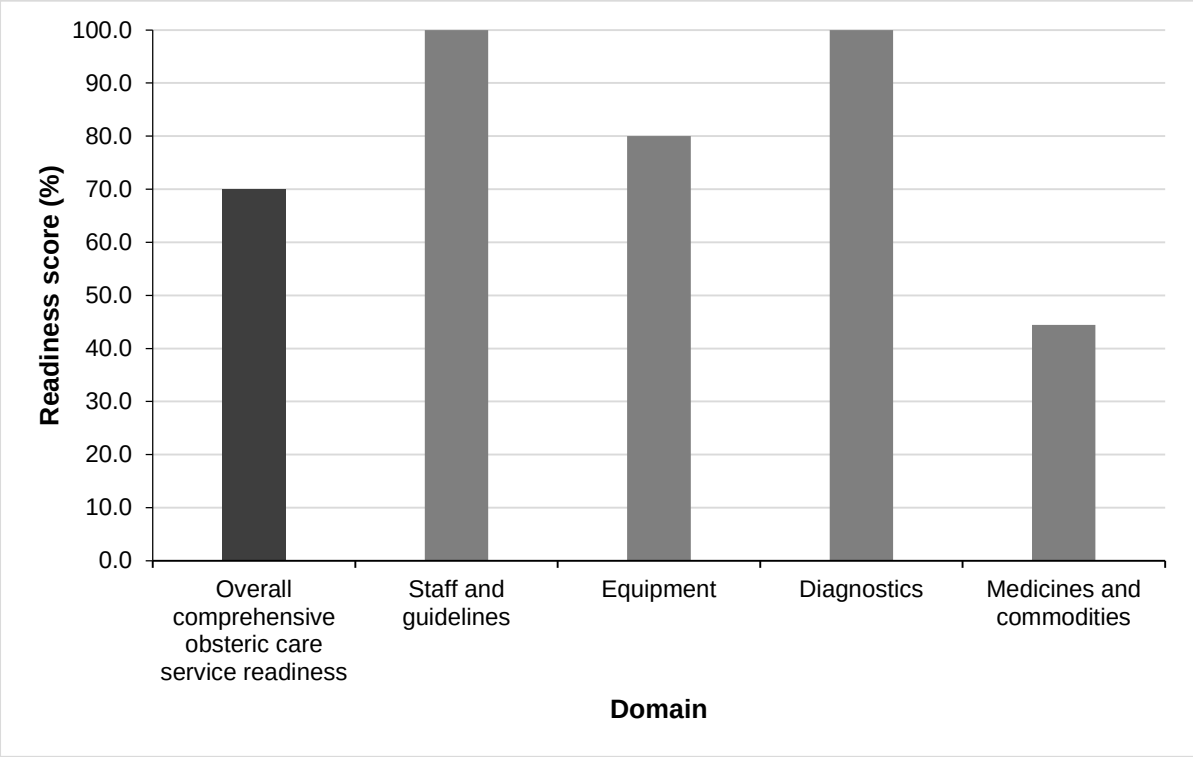
Availability of emergency obstetric care

Figure 3 top



Footnotes:
Staff and guidelines included five tracer items: 1) Guidelines for essential childbirth care; 2) Checklists and/or job-aids for essential childbirth care; 3) Guidelines for essential newborn care; 4) Staff trained in essential childbirth care; and 5) Staff trained in newborn resuscitation
Equipment included 14 tracer items: 1) Emergency transport; 2) Sterilization equipment; 3) Examination light; 4) Delivery pack; 5) Suction apparatus (mucus extractor); 6) Manual vacuum extractor; 7) Vacuum aspirator or D&C kit (with speculum); 8) Neonatal bag and mask; 9) Delivery bed; 10) Partograph; 11) Gloves; 12) Infant weighting scale; 13) Blood pressure apparatus; and 14) Soap and running water OR alcohol based hand rub
Medicines and commodities included six tracer items: 1) Injectable uterotonic (oxytocin); 2) Injectable ampicillin; 3) Injectable gentamicin; 4) Magnesium sulphate (injectable); 5) Skin disinfectant (Chlorhexidine); and 6) Intravenous solution with infusion set

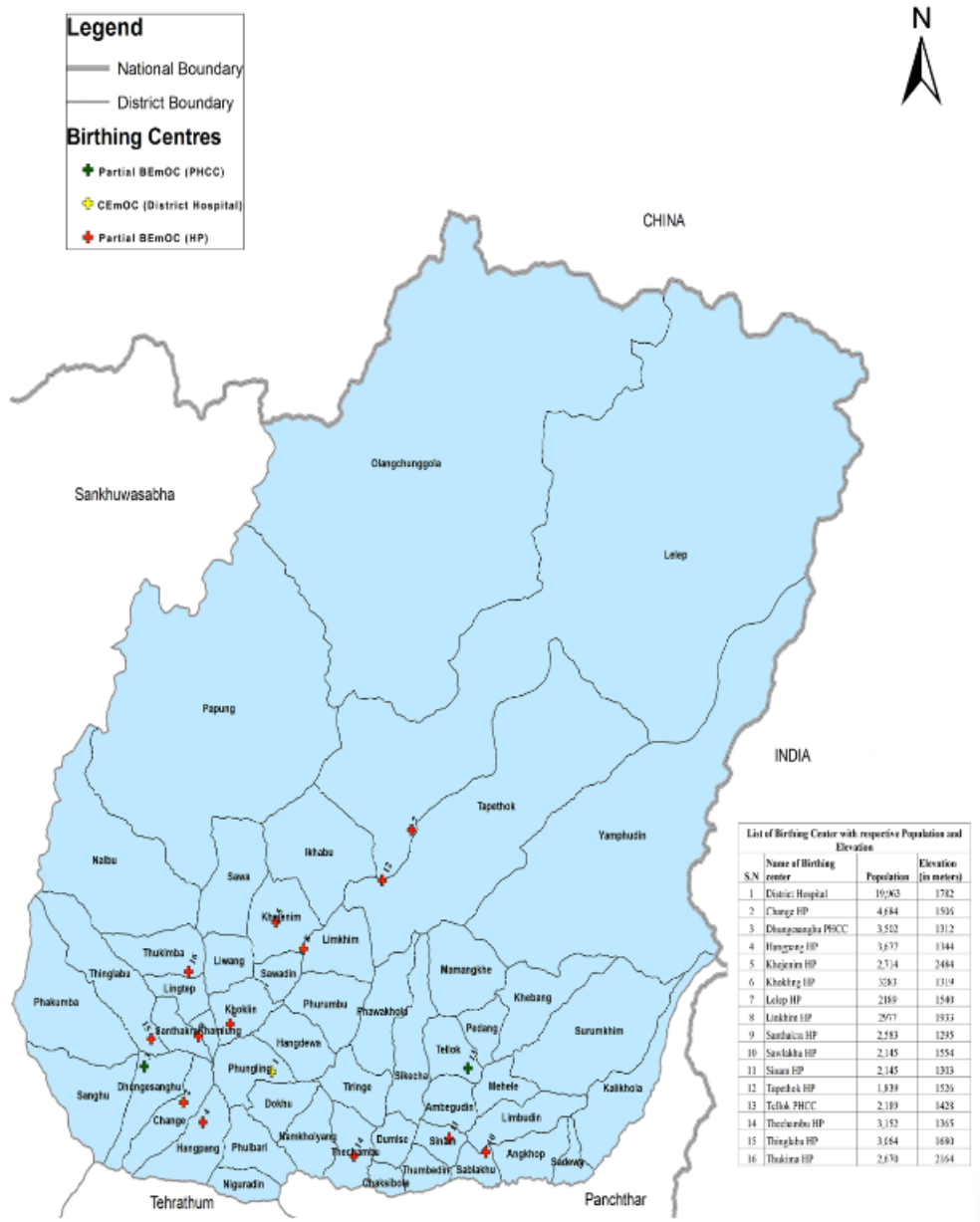
Figure 4 top



Footnotes:
Staff and guidelines included four tracer items: 1) Guidelines for CEmOC; 2) Staff trained in CEmOC; 3) Staff trained in surgery; and 4) Staff trained in anaesthesia
Equipment included five tracer items: 1) Anaesthesia equipment; 2) Resuscitation table; 3) Incubator; 4) Oxygen; and 5) Spinal needle
Diagnostics included two tracer items: 1) Blood typing; and 2) Cross match testing
Medicines and commodities included nine tracer items: 1) Blood supply sufficiency; 2) Blood supply safety; 3) Inj Xylocaine; 4) Epinephrine (injectable); 5) Halothane (inhalation); 6) Atropine (injectable); 7) Thiopental (powder); 8) Suxamethonium bromide (powder); and 9) Ketamine (injectable)

Availability of emergency obstetric care

Supplementary Figure S1 top



List of Birthing Center with respective Population and Elevation

S.N	Name of Birthing center	Population	Elevation (in meters)
1	District Hospital	19,963	1782
2	Change HP	4,684	1536
3	Dhungesangha PHCC	3,502	1312
4	Hangpang HP	3,677	1344
5	Khejenim HP	2,714	2484
6	Khokling HP	3283	1319
7	Lelep HP	2189	1540
8	Limkhim HP	2977	1933
9	Sanhakim HP	2,583	1295
10	Sawlakha HP	2,145	1554
11	Sinam HP	2,145	1303
12	Tapethok HP	1,839	1526
13	Telkok PHCC	2,189	1428
14	Thechumbu HP	3,152	1365
15	Thinglabu HP	3,664	1680
16	Thukima HP	2,670	2164

Figure Captions

Figure 1. Number of health workers at the time of assessment in birthing centres, Taplejung 2018.

Figure 2. Reasons for not performing EmOC signal functions in three months prior to assessment, Taplejung 2018 (n=16).

Figure 3. Overall facility readiness scores for BEmOC

Figure 4. Overall facility readiness scores for CEmOC

Supplementary Figure S1. District populations and distribution of birthing centres in Taplejung, 2017.