Maternal Health 3

The scale, scope, coverage, and capability of childbirth care

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All women should have access to high quality maternity services—but what do we know about the health care available to and used by women? With a focus on low-income and middle-income countries, we present data that policy makers and planners can use to evaluate whether maternal health services are functioning to meet needs of women nationally, and potentially subnationally. We describe configurations of intrapartum care systems, and focus in particular on where, and with whom, deliveries take place. The necessity of ascertaining actual facility capability and providers' skills is highlighted, as is the paucity of information on maternity waiting homes and transport as mechanisms to link women to care. Furthermore, we stress the importance of assessment of routine provision of care (not just emergency care), and contextualise this importance within geographic circumstances (eg, in sparsely-populated regions *vs* dense urban areas). Although no single model-of-care fits all contexts, we discuss implications of the models we observe, and consider changes that might improve services and accelerate response to future challenges. Areas that need attention include minimisation of overintervention while responding to the changing disease burden. Conceptualisation, systematic measurement, and effective tackling of coverage and configuration challenges to implement high quality, respectful maternal health-care services are key to ensure that every woman can give birth without risk to her life, or that of her baby.

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See Online for appendix

Introduction

The Millennium Development Goal (MDG) to reduce maternal mortality did not recommend specific configurations of maternal health-care services, but aimed implicitly, as reflected in its tracking indicators, to ensure high coverage of skilled birth attendant at delivery and antenatal care. Underlying these choices were assumptions that high coverage of skilled birth attendant and antenatal care would put women and their babies in contact with professionals who could manage uneventful pregnancy, labour, and birth, and either prevent, detect and treat, or appropriately refer complications. Additionally, antenatal care sessions provide an opportunity to arrange appropriate childbirth care.

The end of the MDG era showed progress: from 1990 to 2013, global coverage of births occurring with skilled birth attendants increased from 57% to 74%, one or more antenatal visits from 65% to 83%, and four or more antenatal care visits from 37% to 64%.[1,2] However some countries continue to have high maternal mortality ratios, despite high coverage of skilled birth attendants and antenatal care. Such sustained maternal mortality could arise because such indicators track contacts with care and not the content of care; a quality gap might remain despite increases in coverage.[3,4] Furthermore, features beyond skilled birth attendant and antenatal care coverage are likely to be influential. For example, a high population density and short travel times should facilitate access to emergency obstetric care (EmOC), and women's health profiles and life circumstances might also drive health outcomes.

Comparative tracking of maternal health-care provision across different countries has been minimal, apart from the two aforementioned MDG indicators, with only a few indicators and benchmarks used (appendix). In the new era of Sustainable Development Goal (SDG) targets, the shortcomings of use of unidimensional and limited metrics to characterise complex services should be redressed. In this Series paper, we focus on intrapartum care. In the appendix, we briefly describe the status of family planning, abortion, antenatal, and postnatal services. The continuum of care is important, but we chiefly address childbirth services because they are more complex to provide, and because good intrapartum and immediate postpartum care reduce maternal, fetal, and neonatal deaths, and promote health, wellbeing, and enhance child development.[5]

A useful starting point for this Series paper is to lay out pathways that could theoretically lead individual women to receive adequate intrapartum care with skilled birth attendants (figure 1). Informed by this framework, we present a multifaceted characterisation of the main configurations of childbirth services currently used by women in low-income and middle-income countries (LMICs), with some data presented on high-income countries (HICs) for comparison. We begin with the prevailing patterns of where, and with whom, deliveries take place. We then detail the levels of facilities, and facility and staff capabilities, and touch on other aspects of quality, followed by a section on strategies to link women to such intrapartum services. Financing innovations, also essential for improvements to access and quality, are addressed by Koblinsky and colleagues.[6] Finally, we discuss whether current models of service delivery are likely to be fit-for-purpose, and indicate the scope for future change. We make recommendations for data collection for improved planning, provision, and tracking.

Key messages

- Facility and skilled birth attendant deliveries are increasing; this investment should yield multiple benefits, reduce maternal and perinatal mortality, and improve maternal and neonatal wellbeing
- Progress is not as great as expected; phrases such as skilled birth attendant and emergency obstetric care can mask poor quality care; we need to ensure skilled providers for routine and emergency childbirth care, along with timely access to such care
- National health plans need to ensure women, especially the most remote or vulnerable, can reach intrapartum services in a timely way: this requirement will entail understanding of the current use of routine and emergency transport, and patterns of relocation (before the start of labour) to stay near the planned childbirth locale (maternity waiting homes)
- It is unethical to encourage women to give birth in places with low facility capability, no referral mechanism, with unskilled providers, or where content of care is not evidence-based: this failing should be remedied as a matter of priority; childbirth should only be promoted in facilities that can guarantee at least a basic emergency obstetric care standard
- Low-income and middle-income countries could promote births in comprehensive emergency obstetric care facilities, as most high-income countries have done; however, such models can be associated with unnecessary intervention and high costs; to support normal birth, provision of alongside midwifery-led units can be a good choice for many women, such units have the additional advantage that they eliminate the need for inter-facility emergency transfer, although they do not address bottlenecks around initial access
- The current indicator of skilled birth attendant coverage is a unidimensional and limited metric with which to characterise complex services; a more diverse range of indicators is needed to capture the nature and content of care being provided; these data are readily available

Our exploration of childbirth services presents evidence from 50 countries. We drew on academic literature, particularly reviews, and, for a subset of 29 LMICs, we conducted our own analyses (methods detailed in the appendix).

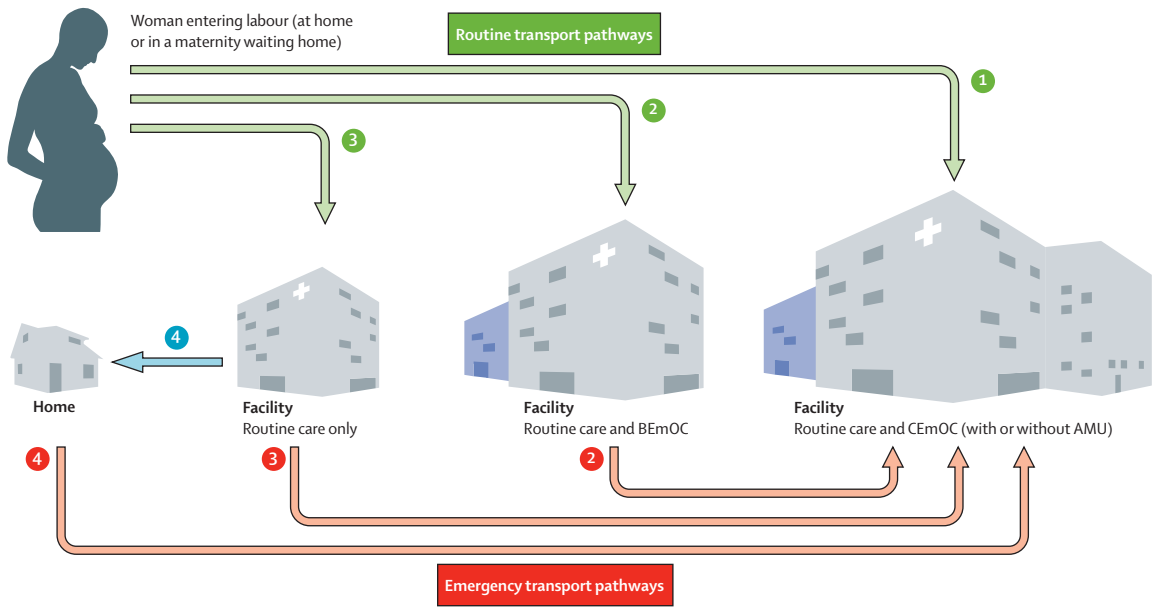
Where do births take place, and with whom?

As well as increases in skilled birth attendant coverage, some countries have increased facility deliveries at astonishing rates (appendix). The intersection between where births take place and with whom captures the endpoint of the paths women take in a given context (figure 1). A provider's designation (eg, midwife or obstetrician) should indicate skills, while a facility's designated level (eg, hospital, health centre, or health post) should signal its capability to provide certain elements of care (eg, comprehensive EmOC, basic EmOC, or routine-only care), and whether a facility is obliged to refer complications elsewhere for treatment.[7] Many unstandardised terms are used to describe provider cadres and facility levels. For example, freestanding midwifery units or private midwife's clinics generally resemble health centres, to the extent that they might be expected to provide basic EmOC (eg, $MgSO_4$), but not aspects of comprehensive EmOC (caesarean section and blood transfusion). Figure 2 shows these childbirth care configurations for 50 countries, with nearly as many patterns as countries. Providers range from no one, to non-skilled birth attendants, to midwives, to doctors; settings include those where births occur mostly at home (eg, Chad 2000–04), predominantly at lower-level health facilities (eg, Senegal 2010–14), or almost entirely at hospitals (eg, Jordan 2008–12). The main cadre of birth attendant in facilities varies (figure 3), from countries where midwives or nurses attend the majority of lower-level and higher-level facility births (eg, Mali 2008–12), to those where doctors prevail (eg, Ukraine 2003–07). In some countries, lower-level facilities births are predominantly with midwives or nurses, while hospital births are with doctors (eg, Indonesia 2008–12). Countries with mostly hospital births (figure 3) vary in their dominant skilled birth attendant cadre.

Are staff skilled?

Skilled staff are essential to provide high quality intrapartum care to each woman and newborn, are a determinant of facility capability, and a requirement for adequate home-based childbirth care (figure 1). Skills include the ability to communicate in a caring, respectful manner, plus the knowledge and technical skills to give appropriate, well-timed care.[8,9] Unfortunately, in many settings women receive neither; systematic reviews[8–13] show substantial disrespect and abuse, and numerous studies show low levels of provider skills and confidence. For example, a study[10] of nine sub-Saharan African countries showed most did not train skilled birth attendants to manually remove placentas. Some countries designate cadres as skilled birth attendants, despite them lacking requisite midwifery skills.[12,14]

Staff numbers matter too. 90% of maternal deaths happen in 58 countries with only 17% of the world's midwives and doctors.[15] Data compiled from 132 countries revealed 64 did not meet the minimum critical threshold of 23 midwives, nurses, and doctors per 10 000 population needed to implement primary care programmes, including intrapartum care (appendix).[16] Shortages of other key providers such as anaesthetists also exist.[17] Furthermore, providers are often poorly distributed (eg, concentrated in urban areas or in the private sector). Low-density settings (remote and rural) are particularly



Requirements for each pathway and option for routine and emergency care

	Routine transport at start of labour	Provision of quality care for routine childbirth		Emergency transport for complications	Provision of quality care for complications (EmOC)
Options to ensure SBA delivery	Woman/family: • Makes decision on intended place of childbirth • Has ability to reach intended location, (transport and communication) including by relocation to a MWH	Facility has adequate: • Staff cadres and skills for routine childbirth • Staff numbers • Equipment, drugs, and supplies • 24/7 opening times and basic infrastructure		Attendant: • Recognises need for emergency care • Can identify and reach CEmOC facility (eg, using emergency medical service)	Facility has adequate: • Staff cadres and skills to manage complications • Staff numbers • Equipment, drugs, and supplies • Blood supply • 24/7 opening times and basic infrastructure
Facility with routine care & CEmOC (1)	Woman travels from home/ MWH to CEmOC facility	Uncomplicated childbirth at CEmOC facility, potentially in an AMU		Travel not required; if in AMU, move to emergancy care located on the same site	Complicated childbirth managed at CEmOC facility
Facility with routine care and BEmOC (2)	Woman travels from home or MWH to BEmOC facility	Uncomplicated childbirth at BEmOC facility	(2)	Woman who cannot be managed at BEmOC facility travels to CEmOC facility	
Facility with routine care only (3)	Woman travels from home or MWH to routine-only facility	Uncomplicated childbirth at routine-only facility	(3)	Woman travels from routine-only facility to CEmOC facility	
Home with SBA (4)	SBA travels to woman's home	Uncomplicated childbirth at home	(4)	Woman travels from home to CEmOC facility	

***Figure 1*: Conceptual framework of pathways leading to adequate childbirth care options**
Skilled birth attendance for uncomplicated childbirth and access to emergency obstetric care to manage complications, and the requirements for each pathway and option to be successful. SBA=skilled birth attendant. EmOC=emergency obstetric care. BEmOC=basic emergency obstetric care. CEmOC=comprehensive emergency obstetric care. 24/7=24 h a day, 7 days a week. AMU=alongside midwifery-led unit. MWH=maternity waiting home.

challenging to provision; providers prefer to work in teams and sometimes resist placements without amenities such as schools.[18–20] Location and facility size often correlate with resources available for hiring, training, supervision, and retention. With insufficient staff, some women cannot get timely care, and end up delivering alone or with non-skilled birth attendants, such as cleaners, despite being in facilities.[21]

What capability do facilities have?

To give high-quality intrapartum care, skilled staff require an enabling environment, and facilities that receive women at any time of day. Specialist back-up care should be part of the plan, via transfer to another facility if needed. Figure 1 designates facilities as capable of providing comprehensive or basic EmOC, or routine care only. Routine care is included for completeness because

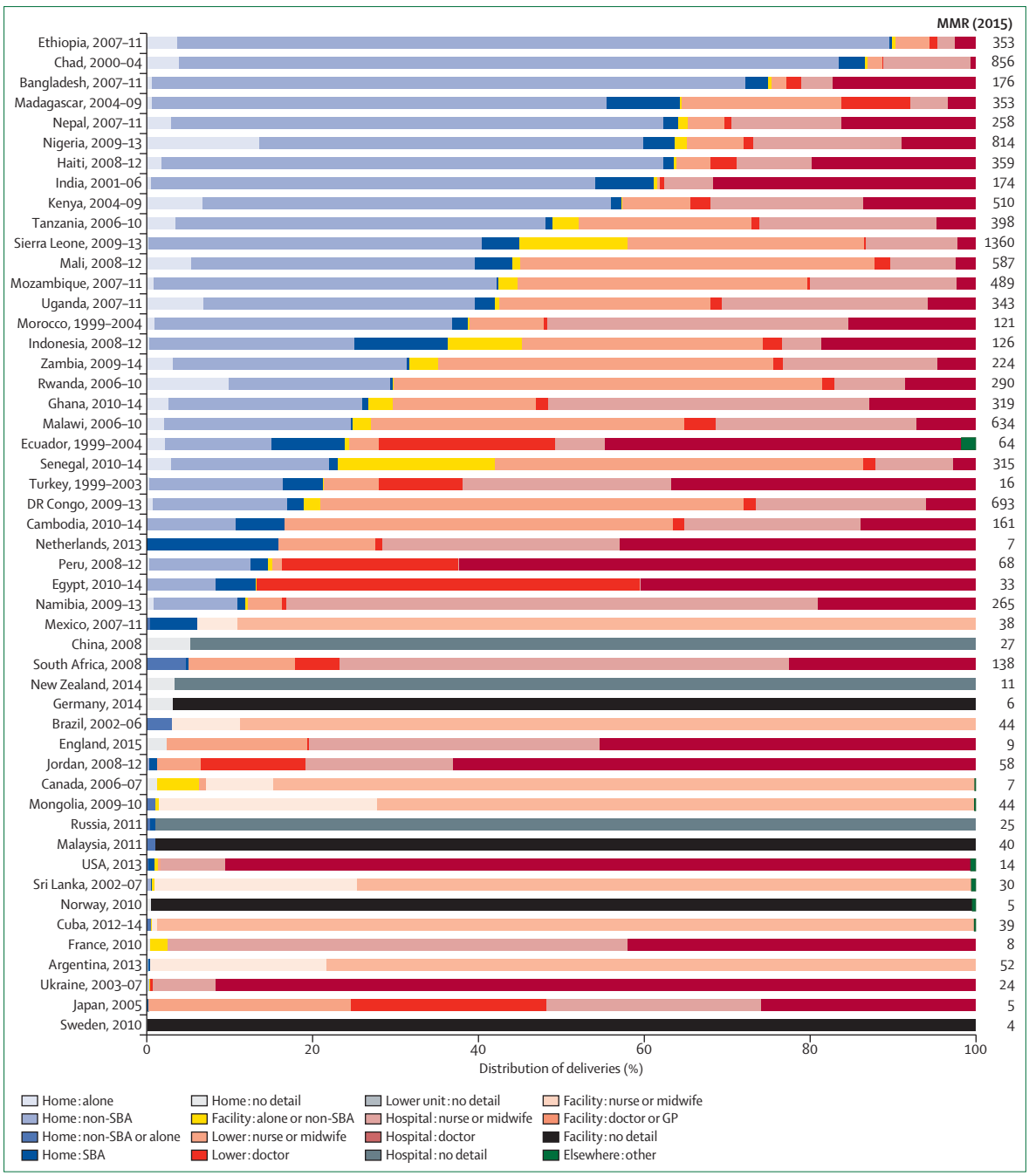


***Figure 2*: Distribution of births by childbirth location and provider attending birth**
MMR=maternal mortality ratio. SBA=skilled birth attendant.

facilities should at a minimum be able to manage some complications, stabilise women, and guarantee transfer to a hospital (ie, be capable of basic EmOC), as well as to care competently and empathetically for routine, uncomplicated births.[22]

Researchers have evaluated the capability of facilities to provide EmOC across many settings using eight signal functions including, for example, provision of parenteral antibiotics (one of six basic functions) and caesarean section (one of two comprehensive functions).[23] Facilities designated as hospitals or even comprehensive EmOC facilities, vary widely in their actual capability to provide such care. Measurement of signal functions frequently extends to include neonatal resuscitation, but we avoided reporting this function because we concur with those who would expand emergency neonatal care beyond just

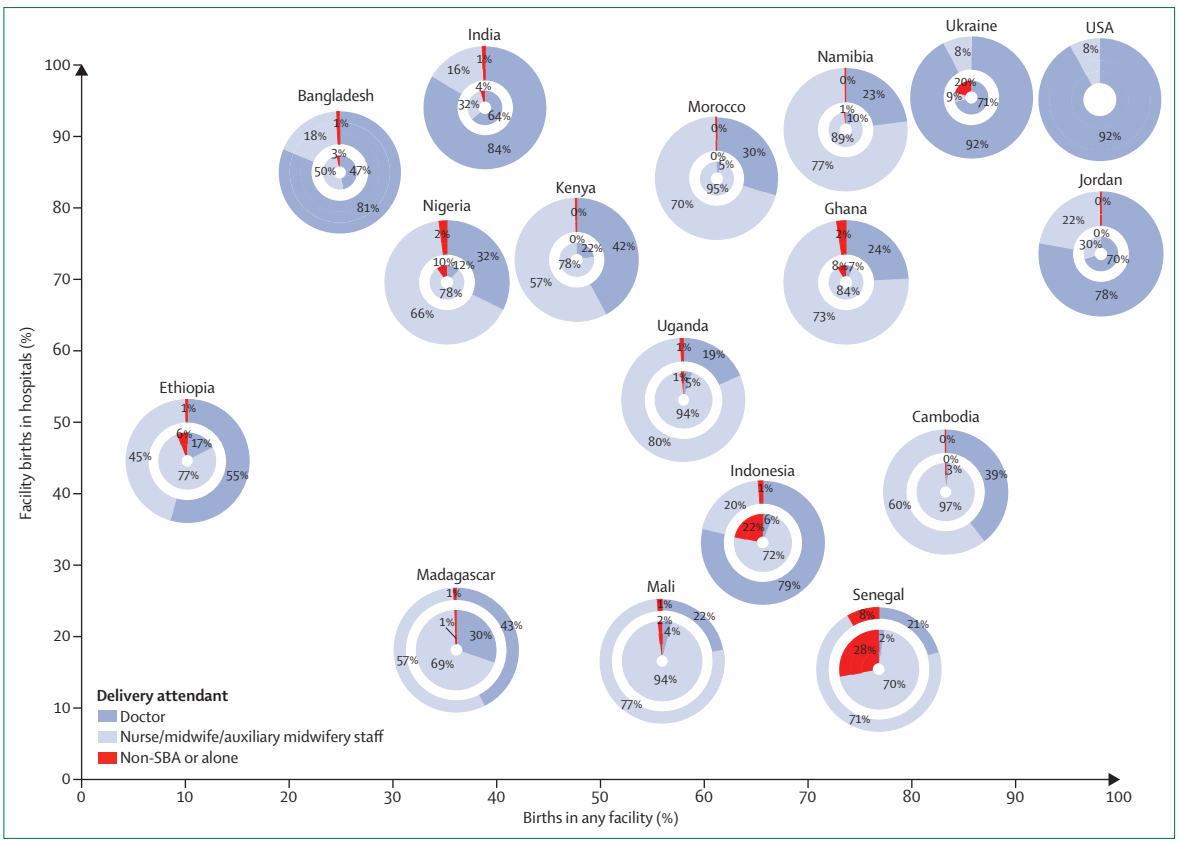


Figure 3: **Percentage of births in facilities, by facility level and cadre of attendant, for selected countries**
SBA=skilled birth attendant. Percentages do not add up to 100 due to rounding. Outer ring represents hospital births and inner ring represents lower-level facility births.

resuscitation.[24] Unfortunately, we lacked data for a broader definition. In nine LMICs, we explored the volume of deliveries, the actual capability of facilities to provide emergency and routine childbirth care, and whether facilities had basic infrastructure.

Volume of deliveries

Facilities of different levels usually have different numbers of beds, providers and provider skill mixes, and different volumes of deliveries handled. Variations across countries reflect differences in geography and population densities, philosophies and policies for childbirth, and health-care systems, but the size and number of facilities also reflect potential difficulties in organisation, provision, and access to care.

Across eight sub-Saharan African countries and China, more than 70% of facilities conducting deliveries were low-volume (<500 births per year), and only conducted a small proportion of all facility births (appendix). For example, in Namibia, 86% of facilities were low-volume, and conducted only 17% of all facility births. Across the nine countries, 17–47% of facility births were in low-volume facilities. Among HICs, few countries have more than a fifth of births in low-volume facilities, and many had none.[25] The nine LMICs also had some very high-volume facilities (≥10 000 deliveries per year), and one study[26] reported some facilities conduct as many as 25 000 deliveries per year.

Emergency obstetric care capability

Facility capability to deliver EmOC was often poor (figure 4A). For example, in Kenya only 16% of facilities could provide EmOC, illustrated in green in column I. Taking into account that more functional facilities had a higher volume of deliveries shifted the balance favourably (figure 4A, column II). In Kenya, 43% of facility deliveries were in EmOC-capable facilities. However, even this more favourable picture demonstrated that in four of eight countries evaluated, most births were in facilities incapable of providing five basic EmOC functions—a vital gap in maternal health care provision. Facilities in China were considerably more likely to provide EmOC than were those in sub-Saharan Africa.

Routine childbirth care

Despite the skilled birth attendant strategy that essentially promotes facility birth, little attention is paid to routine intrapartum care in facilities. Signal functions for routine care, capturing of selected aspects of monitoring and prevention (eg, infection prevention,

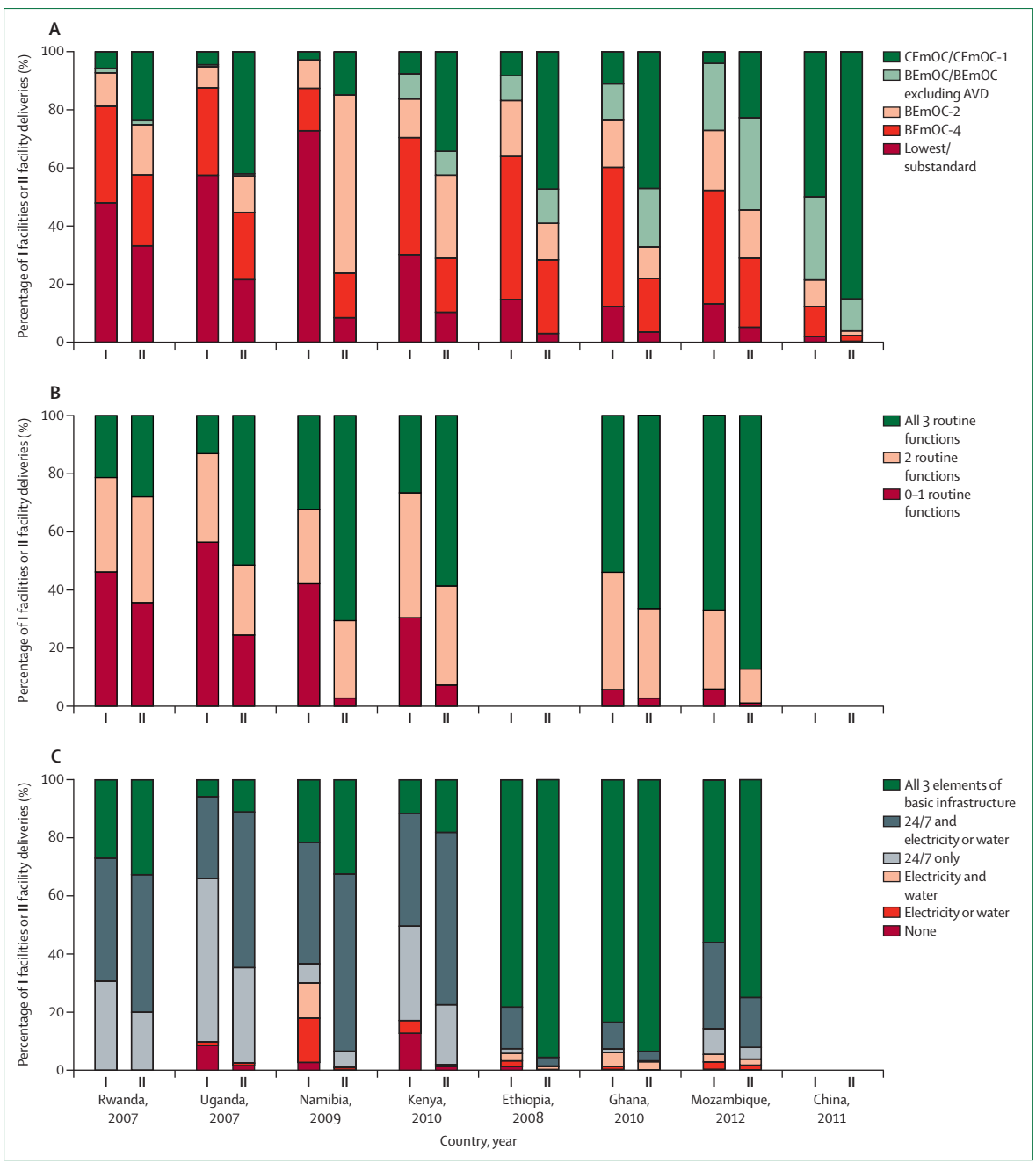


Figure 4: **Percentage facility capability by weighting**

The left hand columns (I) are percentage of facilities; and in the right hand columns (II), percentages are weighted by number of deliveries in each facility, by country, and are thus representative of all deliveries in all facilities: (A) EmOC capability; (B) routine childbirth care capability (infection prevention, partograph, & routine administration of uterotonic); and (C) basic infrastructure. Differences in definitions drive some between-country differences (appendix). EmOC=emergency obstetric care. BEmOC=basic emergency obstetric care. CEmOC=comprehensive emergency obstetric care. AVD=assisted vaginal delivery. CEmOC-1=CEmOC excluding AVD. BEmOC-2=BEmOC excluding two signal functions. BEmOC-4=BEmOC excluding four signal functions. 24/7=service 24 h a day, 7 days a week.

partograph, and routine administration of uterotonic), and signal functions for basic infrastructure were first proposed 15 years after those for EmOC.[24] In six LMICs with relevant data, we showed facilities were generally better equipped to provide routine care than EmOC (figure 4). In Mozambique for example, around half of facility deliveries were in EmOC-capable facilities (figure 4A, column II), but over 75% were in facilities capable of all routine care signal functions (figure 4B, column II). Nevertheless, an unacceptably

high proportion of births occurred in facilities incapable of providng adequate quality routine care.

Basic infrastructure

Results of a national study[27] in Tanzania showed that 56% of facilities conducting deliveries lack water and sanitation, and the results of a systematic review[28] showed 66% of hospitals in sub-Saharan countries lack electricity. Figure 4C shows many facilities were open at all times, but lacked both water and reliable electricity.

Quality of intrapartum care at the individual level

High quality care also requires that all components of routine and emergency care be provided consistently, respectfully, in a timely fashion, and affordably to all women who need it. Individual women's care can be very poor, even when providers and facilities are capable of providing it.[29] However, with some exceptions,[30] coverage of specific elements of care is rarely available at national-level in LMICs, because of the challenges in gathering of such individual-level data from health management information systems, non-electronic medical records, or surveys.

What does it take to access care?

Access to health services remains a challenge for women in many countries; in 2013, met need for skilled birth attendant delivery worldwide was 74%.[1] A 2015 systematic review[31] of met need for EmOC, an indicator that signposts women's use of facilities for complications (assuming 15% of all pregnancies will require such care), estimated that the percentage of women with complications who actually attended EmOC facilities was 21% in low-income settings and 32% in middle-income settings. Economic and cultural barriers play a part in attendance, but an additional reason is the lack of nearby EmOC facilities; few countries meet the benchmark of five fully functioning (as defined by the performance of all signal functions) EmOC facilities per 20 000 births.[32] Another reason is the lack of transport to link women to care. The spatial distribution of women entering into labour, in relation to the location of facilities of a given level, determines distance. Distance, along with mode-of-transport and difficulty of travel (road infrastructure, road quality, traffic, and safety), then determines travel time, and affects the timeliness of obtaining routine and emergency childbirth care.[33]

Strategies to link women to services

Strategies connecting women to routine services (eg, antenatal or childbirth care) frequently differ from those linking them to emergency services (panel 1). Access to routine intrapartum care requires that women in labour be transported to health facilities, or that staff and supplies are transported to women's homes (figure 1). Alternatively, women can move close to services (eg, to maternity waiting homes) late in pregnancy, before they enter labour. For emergencies, referral systems and coordinated emergency transport are needed to transfer patients and communicate critical health records to receiving hospitals.[52–55]

Emergency transport is divided into formal and informal systems. Most HICs, and increasing numbers of LMICs, have formal emergency medical services systems providing ambulance transport and care for patients with all types of emergencies. Four main emergency medical services models exist: no defined formal system, basic life support, advanced life support, and on-scene physicians providing advanced life support.[56,57] Most LMICs lack formal emergency medical services systems, or operate basic life support systems. By contrast, HICs typically use advanced life support (eg, USA and UK) or on-scene physicians providing advanced life support (eg, Germany and France) systems. Although evidence suggests that on-scene physicians providing advanced life support is superior for severely injured trauma patients, limited research has failed to show significant differences in outcomes between basic, advanced, and on-scene physicians providing advanced life support for other emergency patients, and no controlled trials specifically evaluating emergency obstetric patients have been done.[58–61]

Emergency medical technician training should at a minimum include emergency resuscitation and pre-hospital decision skills, such as who should be allowed in the ambulance, and whether in instances with only one provider, the ambulance driver should pull over to help manage an emergency requiring two sets of hands, or keep driving. For emergency conditions such as major trauma and acute myocardial infarction, bypassing of lower-level facilities for higher ones is appropriate because additional transport time is outweighed by improved services and care at higher levels.[52,62] Because of the risk to both mother and baby, and the time needed to set inter-facility referral in motion,[63] women who cannot be managed in situ are likely to be better off being transferred directly to the nearest functioning comprehensive EmOC facility.

Functional emergency medical services systems are resource intensive and demand a coordinated call-centre and ambulance response team. Mature emergency medical services systems in HICs operate single toll-free access numbers, managed by call-centres whose agents dispatch appropriate ambulance services; thus, ambulances are located to optimise response time and resources.[56,64] The number of ambulances required per population varies depending on local factors, such as road conditions, population density, distance, and culturally acceptable response times.[65]

In LMICs, ambulance numbers are increasing rapidly; however, a lack of system-wide coordination compromises their reach and impact (appendix). Unlike in HICs, many

Panel 1: **Routine transport systems and maternity waiting homes: getting women to routine childbirth services**

Routine transport

Emergency complications that cannot be managed in situ generally require women to reach high-level facilities rapidly, but even routine transport for women in labour has to be relatively swift.[34,35] Scarcity of reliable transportation hampers timely care-seeking, with rural populations spending substantial travel time, and incurring high transport costs.[36–39]

Readily available transport and short travel times have a dramatic impact on facility delivery.[40] In high-income countries, rural areas have higher rates of motorised vehicle ownership than do urban locales.[41] By contrast, many low-income and middle-income countries have very low rates of motorised vehicle ownership in rural areas, which further exacerbate disparities in access to high-quality obstetric care. For example, in Kenya a very small proportion of households within Demographic and Health Surveys clusters owned any form of motorised vehicle (appendix). Phone ownership, which facilitates communication, was higher than for vehicles, particularly in urban areas, but was still low in sparsely populated areas.

To improve transport, countries such as India, Nepal, and South Sudan have established fully or partially subsidised transport for women seeking routine obstetric care.[42–44] Provision of formal transport services should increase the rate of facility births, especially among rural and low-income women, but further study of these programmes' designs (eg, staffing, costs, and sustainability) is needed. Travel times to facilities alone do not delineate the entire picture; multiple factors, including perceived low-quality service, lead women and families to bypass smaller local facilities for more emergency obstetric care-capable facilities further away.[40,45] The impact and appropriateness of obstetric patients without known complications who bypass services is poorly studied, but bypassing can indicate dysfunction at lower levels, and cause dysfunction at higher levels, via overcrowding.

Maternity waiting homes

In hard-to-reach areas, women in labour setting out for a distant facility might deliver on route, particularly in low-income and middle-income countries where air transport of women (or skilled birth attendants) to a childbirth site is not available or financially viable.[46] One solution is for women to move and stay adjacent to health facilities towards the end of pregnancy, reducing travel times in labour. These locales can be formal health-sector maternity waiting homes, patient hotels, private hotels, hostel accommodation, or the homes of relatives or friends, sometimes referred to as informal maternity waiting homes. Maternity waiting homes are recommended interventions, although the evidence is weak.[47] Little is known about the scale of maternity waiting homes provision, or the proportion of women using them, although some countries reportedly make considerable use of this approach (eg, Mongolia,[48] Cuba,[49] and Peru[50]). In Canada in 2006–07, 5·8% of women travelled more than a day before birth to another city, town, or community to give birth.[51]

LMICs rely on facility-based ambulances, and lack single access phone numbers, providers trained in pre-hospital care, or ideal accessibility (appendix). Facility-based ambulances allow providers a dual role, providing both pre-hospital and in-hospital care. This dual provision reduces staffing needs, but the absence of designated ambulance providers results in the ambulances themselves being underused. Placement of ambulances at remote, lower-level facilities (health centres), further strains limited staffing resources. Finally, provision of community-based emergency vehicles has shown some initial success, but sustainability, cost, and scale-up are poorly studied.[66] The Cambodian experience provides a good case study (panel 2).

Alongside midwifery-led units

Alongside midwifery-led units, which co-locate the equivalent of lower-level facilities on hospital sites, are an approach to allow women to deliver in lower-capability units while eliminating travel-time to comprehensive EmOC facilities if transfer is needed.[76,77] Such models are used in South Africa[78] (known as onsite midwife-led birth units) and the UK. However, although such units might address high hospital costs, overcrowding, and over-intervention, and obviate the need for inter-facility emergency transport, they do not resolve issues around routine transport of women in labour, especially from remote locations.

Other types of fragmentation hinder linkages as well. In some countries (eg, Indonesia), hospitals and health centres fall under different government departments with little direct relationship. Subnational administrative boundaries, decentralised funding, and multiple public-sector and private-sector funding streams can complicate care for women. Referral protocols that do not recognise the urgency of many obstetric complications to reach the nearest comprehensive EmOC facility can fatally delay care.

Discussion

The MDG5 indicators of skilled birth attendant and antenatal care coverage are insufficient to characterise the maternal health-care systems of countries, or indicate the likelihood of achieving good outcomes. Unless other aspects linked to quality and timeliness, ensuring of respectful care and other elements of coverage are addressed, achievements towards improving maternal health could be overestimated. Policy makers need information to contextualise their countries along a number of potentially successful pathways to high

Panel 2: Emergency transport systems in Cambodia

Improvements

- Cambodia's maternal mortality ratio has dropped from 1020 per 100 000 livebirths in 1990, to 484 per 100 000 in 2000, to 161 per 100 000 in 2015, meeting the MDG5 target.[67,68]
- In 2014, 83% of births occurred in facilities, and 89% were assisted by an SBA, compared with 22% in facilities and 44% assisted by an SBA, in 2005.
- Related services also improved: by 2014, 95% of women had at least one antenatal visit, 76% had more than four antenatal visits, and 85% received postnatal care within 2 days of birth. Modern contraception increased to 39% and unmet need was down to 13%. Induced abortion is legal up to 12 weeks' gestation. The government-backed EmONC improvement plan (2010–14) and finances to provide services,[69] coupled with efforts to expand and strengthen financial schemes that assist low-income patients to use services, have been instrumental in Cambodia's progress.[70,71]

Gaps in care

- Despite this forward momentum, and the fact that most of the population reside within 2 h of a health centre, significant gaps remain in the number and distribution of functional EmONC services across Cambodia, with 2·35 EmONC-capable facilities and 1·31 comprehensive EmONC-capable facilities per 500 000 population. Global benchmarks require five EmONC-capable facilities and one EmONC-capable facility per 500 000 population.
- Only around 24% of all births occurred in functional EmONC facilities; EmONC services are highly concentrated in urban centres, leaving rural areas without essential services.[69,72]
- Most designated EmONC facilities not achieving functional status were health centres incapable of assisted vaginal delivery, manual removal of placenta, or provision of parental anticonvulsants or neonatal resuscitation.

Referral systems

- Referral systems linking patients to available emergency obstetric care services remain a challenge in Cambodia. Although nearly all health centres have a phone service and are located within 2 h of higher-level care, and hospitals have functional on-site ambulances, breaks in the referral system persist.
- Very few health centres have their own emergency transport, and 60% of health staff report routinely helping patients arrange private transport.[69]
- National policies require trained staff to accompany patients during transport, a practice used in three-quarters of referrals by health centres. However, the accompanying staff is frequently a midwife or nurse without emergency medical technician training.

Ambulances

- In 2015, China donated 200 new ambulances to Cambodia that were distributed to public facilities across the country, bringing the estimated total number of functional ambulances nationwide to more than 400—about one ambulance for every 35 000 people.
- Recommendations for LMICs range from one ambulance per 20 000 population to one per 100 000.[65,73]
- Ambulances remain primarily hospital-based and hospital-administered.
- No centralised access number or dispatch system exists, leading to vast underuse of ambulances, protracted response times, and vehicles falling into disrepair.
- Obstetric emergencies are among the most common reasons for seeking of emergency transport, with fees being reimbursed by government, and donor-backed low-income assistance programmes.[74,75]
- Unfortunately, rates charged to patients vary widely, and reimbursements often fail to cover the entire cost of transport.[74] Taken together, these challenges have led to a lower than expected number of referrals and unnecessary delays in care.

Quality improvements

- Multiple quality improvement efforts are underway to improve linkages between facilities in Cambodia.
- Quarterly Midwifery Coordination Alliance Team meetings have successfully brought together health centre midwives, operational district administrators, and local and provincial referral hospital staff to review referrals, discuss improvement opportunities, and conduct education on key maternal care practices.
- Additionally, current efforts to standardise referral guidelines and promote provincial-level obstetric care hotlines will help Cambodia continue its progress in advancement of maternal health.

SBA=skilled birth attendant. EmONC=emergency obstetric and neonatal care. LMICs= low-income and middle-income countries.

quality and effective services, to identify breaches in these paths, and review their direction of travel.

The SDG era provides an opportunity to review, refine, and plan carefully to ensure health-system developments better meet the needs of pregnant and delivering women and their babies, as well as the needs of women who require other reproductive and general health services. Our conceptual framework (figure 1) illustrates that for childbirth, the essential features to explore are the birth location and its capability, the skills of the birth attendant, and the ability of women to access routine and emergency care. A clear understanding of these features, coupled with an appreciation of the geography and other contextual factors of a setting, is needed to

comprehensively illustrate the current situation of maternal care for multi-country or sub-national comparisons, and to develop evidence-informed options. Great variability is seen in these maternal health-system features across countries, some of which achieve good results, and others which do not.

What existing patterns tell us about home births

Among the 50 countries we examined for this Series paper, home births ranged from 0·1% to 90%. The ability to achieve safe and respectful care for home births depends on who attends, and how successfully home births are integrated into effective formal-sector services, including via emergency medical services. In general, the higher the home birth percentage, the lower the percentage of births that were with skilled birth attendants (eg, in Ethiopia in 2007–11, 90% of births were at home, of which only 0·4% were with skilled birth attendants). Most home births in LMICs were either with traditional births attendants (eg, 89% in Bangladesh in 2007–11), with relatives or family (eg, 61% in Ethiopia in 2007–11), or alone (eg, 34% in Rwanda in 2006–10).

When non-skilled birth attendants attend home births, potential interventions include birth preparedness and complication readiness,[79,80] and links to the formal health-system.[79,81] Generally, this configuration is associated with high maternal mortality and poor perinatal outcomes.[7]

When skilled birth attendants attend substantial proportions of home births (eg, in Indonesia, Sierra Leone, and Cambodia), women need ways to call them when labour starts and attendants might need transport to get to the birth. For such models to yield low maternal mortality, midwives and doctors should be competent in provision of routine care and emergency first-aid; they also need to be integrated into formal systems of training, supervision, and skills retention, even if they work privately. In HICs, home births were less than 5%, except in the Netherlands (15% in 2013) and, when planned, were mostly with skilled birth attendants. Evidence-based UK guidelines show home births with midwives are safe for multigravida with uncomplicated pregnancies.[82] Planned out-of-hospital births in the USA have worse perinatal outcomes, but nearly a quarter had no skilled birth attendant and more than a third lacked insurance compared to less than 1% of planned hospital births.[83] Comparable clarity for LMICs is lacking. Historical examples of success with skilled birth attendant-attended home births exist, for example in Malaysia.[7,84] However, evaluation of the national Indonesian midwifery programme showed that although skilled birth attendants for home births increased, maternal mortality remained high, even among women who received professional care.[85,86] These findings suggest home-based midwifery care can fail, possibly because midwives were insufficiently trained or skilled, care was not well-timed, and access barriers to EmOC remained, or even widened.

Irrespective of attendant, home births need emergency medical services options to get women to hospitals should complications arise. This need is a bottleneck, with few national-scale emergency transport schemes in LMICs. For example, in Ethiopia (2007–11), where 90% of women delivered at home, household ownership of motorised vehicles was low, a universal access telephone number was not available for emergency medical services, and few patients were transported by ambulance. Although Ethiopia is redressing low coverage—its national survey (2010–14) shows 16% facility birth,[87] and others show 43%[88]—such a configuration cannot, and does not, achieve low maternal mortality (Ethiopia's maternal mortality ratio is 353 per 100 000 livebirths).[67] Many women in many countries live far from EmOC-capable facilities, and motorised transport is inaccessible or unaffordable in some rural areas. In urban areas, traffic can delay arrival. Emergency transport innovations, including those instigated by women's groups, have been proposed but not scaled-up.[89] India might provide a pragmatic future model via its emergency medical service innovations.[42,43] Inappropriate decisions made by families can also delay seeking of emergency care and also needs to be addressed.

In summary, where home-based models of care predominate, most women and family decision makers are unable to navigate the pathways to care, as evidenced by the low proportion of expected emergencies that actually arrive at facilities,[31] and the resultant high maternal mortality ratios (figure 2).

What existing patterns tell us about facility births

Global expansion of skilled birth attendant coverage has occurred largely via increased facility delivery, which is now almost universal in some LMICs, and most HICs. In the 50 countries analysed for this Series paper, facility births ranged from 10% to 99% of all births, with hospitals comprising 17–100% of all facility births. Yet, given that facility births constitute formal-sector provision, it is deplorable that many facilities fail to provide skilled, high-quality, respectful care. Most facilities we studied in sub-Saharan Africa, but not China, were ill-equipped to provide EmOC, especially lower-level facilities. Similar unacceptable findings are reported elsewhere.[90,91] Moreover, many facilities could not even provide routine childbirth care or lacked necessities such as electricity or water. Such functions should be improved to enable high quality and respectful care, and to improve patient and provider satisfaction.

Some women report delivering in facilities without a skilled birth attendant: 0–5% of facility births in most LMICs, but in Senegal (2009–14), for example, as high as 28% of births in lower-level facilities and 8% in hospitals. Other studies report that providers classified as skilled birth attendants are not actually skilled,[11] and that numbers of staff deployed are frequently too low, exacerbating low facility capability.[92] Women in many

settings leave facilities quickly, without discharge checks.[93] These findings beg the question as to why women are encouraged to deliver in such circumstances with low facility capability, poor provider skills, and inadequate lengths of stay, and these issues should be remedied as a matter of priority.

The imperative for countries that have achieved demand for facility birth, and ensured some form of access, is to improve quality, including EmOC capability, and inter-facility links and emergency medical services. Countries where nearly all deliveries occur in facilities have opted largely for births in hospitals with caesarean-section capability. Trends in HICs have been towards centralisation of health services, leading to fewer, larger-volume facilities, and less rural provision. The changes in HICs are driven partly by desires to improve patient safety and cut costs, and indirectly by challenges that remote facilities face in recruitment and retention of providers, and by increased regulations reducing profitability of private-sector maternity services.[94–99] However, a low number of units erodes patient choice, and increases travel time,[95] and very large hospitals can be difficult to manage. Mega-hospitals, with at least 10 000 births per year, which are seen in some countries can yield peculiar ecologies of non-evidence-based childbirth practices, including high levels of augmentation, caesarean-section, crowding, and very short lengths of stay.[29,100]

Countries where hospital births are nearly universal are approaching, or are already below, the new 2030 maternal mortality ratio target of 70 per 100 000 livebirths or less, irrespective of the front-line cadre.[101] *The Lancet*'s 2014 Midwifery Series[102] provided hypothetical evidence for midwives as the preferred main skilled birth attendant and front-line provider. In countries where most facility births are in hospitals, the mix of cadres varies: in Morocco (2000–04) and Namibia (2009–13), for example, midwives predominate, with a non-trivial proportion of doctor-led births, whereas in Ukraine (2003–07) and the USA (2013) doctors lead. We have insufficient data on the front-line provider (particularly for HICs) to compare maternal and neonatal outcomes in countries where different cadres predominate (figure 2).

Some countries, such as Bangladesh and Haiti, have low coverage of skilled birth attendants and facility birth, but women who do get facility care are mainly in hospitals (rather than lower-level facilities), and attended by doctors. This pattern either reflects grossly unequal availability and accessibility in which only a privileged minority access care, or alternatively could arise if emergency referral functions, and hospital-based providers primarily attend women with complications.[103] In Bangladesh, travel times are short, so women with complications can reach hospitals quickly, possibly explaining why the country's maternal mortality ratio is relatively low considering its low skilled birth attendant coverage.[104] In other settings, this pattern reflects sizeable inequality and condemns many women and newborns to death.

The Lancet's 2006 Maternal Survival Series promoted childbirth in lower-level facilities capable of basic EmOC provision, ideally staffed with midwives, for LMICs.[22] These facilities were promoted because of shorter travel times, reduced cost, and reduced likelihood of over-intervention. Some countries appear to have adopted this model (eg, Senegal and Uganda); however, in view of our findings that health centres in many settings have suboptimal capabilities and are not capable of basic EmOC we question whether this model was actually adopted. Tanzania expects deliveries to occur at even lower levels: health posts and dispensaries.[105] Such low-volume facilities are numerous, and of particular concern despite often being the closest facilities to remote rural women; even if provisioned as childbirth venues, their staff might have insufficient training or opportunities to practise and maintain competency in intrapartum care, and links to emergency medical services are frequently poor.[106,107]

What do we want for the future?

Facility and skilled birth attendant deliveries are increasing, but in many LMICs, urban, and richer women use these services much more than rural and poorer women.[108] To serve women, and achieve universal coverage, this discrepancy needs to be remedied. Moreover, governments and policy makers can no longer pretend to provide life-saving care, using phrases such as skilled birth attendant and EmOC to mask poor quality; skill and emergency care need to actually be provided, adequate numbers and training of staff should be ensured, capability and basic infrastructure of facilities should be improved, timely referral should be ensured where necessary, and women should get appropriate high quality content of care.[29]

Chronic underinvestment in the health workforce and the resultant global shortage of health-care workers is well known and extends to skilled birth attendants, particularly in low-income countries.[109] Ultimately, overburdened, underskilled, and underappreciated health workers are compromised to deliver quality maternal health care, and lack resilience to shocks (eg, as observed in the 2014 Ebola outbreak).[20,110,111] Unfortunately, we found few national examples in which the skilled birth attendant workforce substantially grew in a short timeframe.[112] Initiatives to increase provider numbers have included training staff to work abroad (eg, Cuba[113]), recruitment of staff from others countries (eg, Cuban doctors in Brazil[114] and Africa[115]), scaling up of training programmes to locally train sufficient numbers (eg, in Indonesia and South Africa[116–119]), and task shifting (eg, Mozambique[120,121]). *The Lancet*'s Commission on Health professionals for a new century,[122] suggests ways to sustainably improve health worker education in general, and programmes exist in

a number of countries (including e-health distance-learning approaches in Rwanda, and modernisation of curricula and development of continuing, in-service education in Mozambique, Sudan, Thailand, and Yemen).[123] However, evidence that these suggestions achieve sustainable, long-term success is limited. Rollout of task-shifting programmes has been hampered by political, capacity, quality, and other resource challenges,[119,124] and while task-shifting programmes increase health-care coverage in some cases, success is not at a sufficient scale to improve population-level maternal health outcomes, with some notable exceptions.[125,126] Teamwork, as recommended in *The Lancet*'s 2006 Maternal Survival series,[18] is an alternative potential solution.

We support facility delivery, but not in facilities that fail to reach at least basic EmOC standards, unless countries are explicit about how such places will cater for emergencies. It could be argued that LMICs should emulate HICs, and opt for births in facilities capable of comprehensive EmOC. However, such models are associated with high intervention rates in some HICs, and even higher intervention rates among wealthier women in poorly regulated LMIC health-systems.[29,127] Some HICs (eg, the UK) are increasingly encouraging low-risk women to opt for home births with skilled birth attendants, or birth in lower-level free-standing, midwifery-led units, or in alongside midwifery-led units.[128]

Average travel times to the lowest-level facilities are generally shortest, but frequently these cannot even provide routine care, much less emergency care. To improve geographical access for women in labour and timeliness of care, governments could improve functionality of lower-level facilities, or institute maternity waiting homes, or support routine transport to EmOC-capable facilities. Either all women who enter into labour should be within travelable distances to comprehensive facilities, or if they can only reach lower-level facilities, these must have well-functioning maternal care, with excellent strategies for linkage to emergency medical services.

In this Series paper, we focused on the pathways linking women to intrapartum services. Looking more widely, we recognise the continuum of care[129] and the need to link across services, and develop new non-traditional maternity services that respond to the obstetric transition being observed globally.[130] Ensuring maternal health systems synergise with emerging neonatal strategies and structures is also beneficial. Dickson and colleagues[36] did a multi-country review of health system bottlenecks for newborns and identified solutions we further endorse for women, including workforce planning to increase numbers and upgrade specific skills, incentives for rural workers, financial protection, and dynamic leadership such as innovation and community empowerment.

Data needs: moving towards universal indicators for maternal health services

The data we collated and analysed show how previously underused information can describe the configurations of maternal health services better. Our main sources were the Demographic and Health Surveys and health-facility assessments. Together, data from these sources enabled us to illustrate the diversity of maternal health models across a range of LMICs, and to pinpoint some common bottlenecks preventing women from receiving high-quality routine or emergency childbirth care. These same sources can generate the same indicators at sub-national level. Complementary indicators, on GDP, health-expenditure, policies (such as the legality of abortion), and estimates of the extent of private-sector coverage, content of antenatal care, caesarean-section rates, length-of-stay, postnatal care coverage, and unmet need for family planning, can round-off our understanding, particularly if tabulated by indices of inequality, and coupled with health status indicators, such as obesity, HIV prevalence, maternal mortality ratios, severe morbidity, and fetal and neonatal mortality. Ultimately, strong national data systems need to be built to inform policy, and focus investment and resources, ideally linked and aligned to similar processes for newborns.

We acknowledge some data limitations in our analysis. First, the facility designation and the cadre of the health professional are often recalled by women (eg, in the Demographic and Health Surveys) and are subject to recall errors and can be an inaccurate reflection of the actual facility capability[131] or providers' actual skills.[11,132] Second, some data were more than 10 years old, which is problematic when extensive changes occur (eg, Ethiopia or India). This limitation underlines the importance of relatively frequent data collection. Health management information systems, such as DHIS2,[133] could rectify this limitation, provided they include private providers (because these providers conduct many deliveries).[134] Health management information systems are also advantageous because they provide subnational, district-level data.

In addition, we identified some critical data gaps. Signal functions for routine maternal (and for newborn care) need to be more widely adopted, collected via public-sector and private-sector facility assessments, and ideally, be updateable and in the public domain. The ultimate challenge is to measure how many women actually receive key elements of routine childbirth care and whether all women who require emergency care actually receive it, respectfully, and promptly. Data also need to be captured for unnecessary interventions. This challenge requires investments to improve record-keeping and change health management information systems, as was done successfully in Ecuador.[30] The maternal and newborn research communities need to come to consensus on which

coverage, quality, and timeliness indicators they can effectively field at scale. These indicators need to be defined clearly and implemented consistently to compare across countries.

Parallel investments in development of tools for planning, monitoring, and advocacy are also vital. For example, consensus on the numbers of births a full-time midwife can do per month, and tools enabling managers to accurately calculate staffing requirements overall, and on a daily basis, would support more effective planning, deployment, and cost-savings.[135] Improvements to existing planning tools, such as the OneHealth Tool, would extend reach, and help countries achieve human resource plans for maternal, fetal, and newborn care.[5,136] Similarly, more sophisticated use of mathematical and geographical models now available have great potential to inform improved service configurations. For example, a study[64] in Ethiopia modelled the effect on coverage of adding vehicles and communication capability or upgrading strategically located facilities, and changing the configuration of referral networks, and found that the optimal strategy reduced mean travel time from 2 h to 1 h.

Conclusion

A powerful body of data is available to examine current configurations of childbirth care, and to begin to evaluate whether maternal services meet the needs of women. In view of the enormous range of contexts, we cannot recommend one configuration of care. These decisions need to be made locally and nationally. However, we can reiterate that facility deliveries only make sense if they can provide safe routine services, as well as basic EmOC and referral capability to guarantee women with complications are appropriately managed in a timely manner (at a minimum). We note a number of missed opportunities to generate evidence: data for routine care, maternity waiting homes, transport, and inter-facility transfers are particularly limited. Considerable investments are needed to enable the national and global stakeholders to identify critical gaps in national and sub-national service delivery, agree indicators, collect and analyse data, and take up and act on evidence.

Although it is not novel to call for improved understanding, data, and planning, now is an opportune time to re-evaluate existing metrics, in view of pressures to re-organise and diversify maternal services in the SDG era. National governments and providers have to ensure quality services. UN agencies, donors, national governments, and private actors can work to harmonise new indicators, improve routine data collection and real-time analysis, and systematise periodic household and facility surveys. Conceptualisation, systematic measurement, and effective tackling of coverage and configuration challenges to implement high quality, respectful maternal health care is key to ensure that every woman can give birth without risk to her life, or that of her baby.

Contributors

OMRC, CC, AT, MS, FD, MK, and PB conceptualised the series paper. OMRC, CC, AT, MS, SG, MK, and SS did the literature search. CC, LB, EK, DM, CR, LR, and PB did the data analysis. Figures were done by CC, LB, SG, EK, DM, LR, and PB. All authors contributed to data interpretation. OMRC, CC, AT, MS, EK, and PB wrote the review and all other authors commented on multiple versions.

Declaration of interests

We declare no competing interests.

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