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INTRAPARTUM-RELATED DEATHS: EVIDENCE FOR ACTION 5

60 million non-facility births: Who can deliver in community settings to reduce intrapartum-related deaths?

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ABSTRACT

Background: For the world's 60 million non-facility births, addressing who is currently attending these births and what effect they have on birth outcomes is a key starting point toward improving care during childbirth. **Objective:** We present a systematic review of evidence for the effect of community-based cadres—community-based skilled birth attendants (SBAs), trained traditional birth attendants (TBAs), and community health workers (CHWs)—in improving perinatal and intrapartum-related outcomes. **Results:** The evidence for providing skilled birth attendance in the community is low quality, consisting of primarily before-and-after and quasi-experimental studies, with a pooled 12% reduction in all cause perinatal mortality (PMR) and a 22%–47% reduction in intrapartum-related neonatal mortality (IPR-NMR). Low/moderate quality evidence suggests that TBA training may improve linkages with facilities and improve perinatal outcomes. A randomized controlled trial (RCT) of TBA training showed a 30% reduction in PMR, and a meta-analysis demonstrated an 11% reduction in IPR-NMR. There is moderate evidence that CHWs have a positive impact on perinatal-neonatal outcomes. Meta-analysis of CHW packages (2 cluster randomized controlled trials, 2 quasi-experimental studies) showed a 28% reduction in PMR and a 36% reduction in early neonatal mortality rate; one quasi-experimental study showed a 42% reduction in IPR-NMR. **Conclusion:** Skilled childbirth care is recommended for all pregnant women, and community strategies need to be linked to prompt, high-quality emergency obstetric care. CHWs may play a promising role in providing pregnancy and childbirth care, mobilizing communities, and improving perinatal outcomes in low-income settings. While the role of the TBA is still controversial, strategies emphasizing partnerships with the health system should be further considered. Innovative community-based strategies combined with health systems strengthening may improve childbirth care for the rural poor, help reduce gross inequities in maternal and newborn survival and stillbirth rates, and provide an effective transition to higher coverage for facility births.

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1. Introduction

Every year an estimated 60 million women give birth outside health facilities, mainly at home, and 52 million births occur without a skilled birth attendant (SBA) [1]. Access to skilled care at birth and especially to emergency obstetric care (EmOC) is lowest for the poor, who carry the burden of maternal and neonatal morbidity and mortality related to complications of childbirth. Globally, the lowest

rates of skilled birth attendance are in South Asia and Sub-Saharan Africa, and progress to achieving universal skilled attendance is staggeringly slow, particularly in Sub-Saharan Africa, where the average increase in skilled birth attendance is rising by only about 0.2% per year [2]. At this rate, by the Millennium Development Goal (MDG) target date of 2015, still fewer than half of births in the region will occur with an SBA [3]. The long-term strategy to reduce mortality and morbidity related to intrapartum hypoxia (previously loosely termed “birth asphyxia”) requires strengthening of weak health systems to provide universal skilled birth attendance and improving the quality and equity of skilled obstetric care, as discussed in prior papers in this Supplement [4–6]. In this series we follow the

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recommended shift in terminology based on a series of international consensus statements to use the terms “intrapartum-related deaths” for cause of death and “neonatal encephalopathy” for the acute complications manifesting soon after birth [2,7,8]. One-hundred newborns die every hour from intrapartum-related events, however, many of which are preventable. Thus, there is an urgent need for effective solutions that will overcome implementation bottlenecks to reach those most in need and build toward long-term solutions.

For the 60 million non-facility births, a key starting point is identifying who is currently attending these births and the competence, confidence, and connectedness to the health system that they possess. In fact, many home births occur without any attendant or with a family member; for example, in Sub-Saharan Africa approximately 30% of births are unattended or only attended by family members (Fig. 1). For settings where home births are attended by community members, the existing cadres vary by region, mortality setting, culture, and existing health system infrastructure [3,9]. They may also differ widely in their characteristics, training, and skill set to intervene for intrapartum-related outcomes (Table 1). Their principal role in the prevention of intrapartum injury to the fetus and newborn is in primary and secondary prevention, and there may additionally be a role for referral in tertiary prevention [2]. Community-based SBAs, including midwives, auxiliary nurse midwives, or physicians may be common in intermediate mortality settings where there are increased human resources and capacity for training, such as in Indonesia where the government systematically scaled up community midwives [10], or where private providers have a relatively strong presence in the provision of primary care in peripheral health clinics, as in South Asia (Fig. 1). In higher mortality settings, home births are frequently attended by traditional birth attendants (TBAs) who lack formal medical training, but have been care-givers for generations of pregnant women. In Sub-Saharan Africa and South Asia, an average of 23%–40% of births are attended by TBAs [1] (Fig. 1), and approximately half of the TBAs were formally trained in modern medical childbirth techniques with a focus on clean delivery. Community health workers (CHWs) and government extension workers are a final cadre of providers who may have a higher level of education than TBAs, provide prenatal care, health promotion, attend births, and interface with the formal health system.

Engaging community-based cadres to advocate for and/or directly provide essential obstetric-newborn care is controversial [11,12], but may have both advantages and disadvantages that need to be considered. Community-based health providers live ideally within the community in which they work, understand local culture and customs

surrounding pregnancy and childbirth, and are likely to be well respected by community-members, thus increasing the acceptability and uptake of interventions and galvanizing behavior change [13]. On the other hand, community-based providers may be firmly entrenched in traditional customs that may either be potentially harmful to the newborn or the mother, or delay the receipt of appropriate care [14].

1.1. Objectives

The present paper is the fifth in a series on intrapartum-related deaths. The main objective of this paper is to review the evidence for the effect of care by different community cadres during pregnancy and childbirth. In a previous paper in this series, we evaluated community-based strategies to increase demand for skilled childbirth care at health facilities [6] and neonatal resuscitation provided by community-providers [5]. In the present paper, we focus on the effectiveness of each cadre for the primary and secondary prevention of intrapartum-hypoxic injury. As described in the first paper in this series [2], we use GRADE criteria to assess the quality of evidence for the mortality-effect of these community-based providers on outcomes related to acute intrapartum hypoxia, including stillbirth rate (SBR), perinatal mortality rate (PMR), intrapartum-related neonatal mortality rate (IPR-NMR), early neonatal mortality rate (ENMR), and neonatal mortality rate (NMR). We also sought evidence on intermediate outcomes such as care seeking, skilled birth attendance, facility-based delivery rates, and cost and cost-effectiveness.

2. Methods

Details of the searches undertaken and the selection criteria for inclusion are described in the first paper in this series [2]. Searches of the following databases of the medical literature were conducted: PubMed, Popline, EMBASE, LILACS, IMEM, African Index Medicus, Cochrane, and World Health Organization (WHO) documents. The initial search was conducted in November 2002, and was updated May 2009. Keyword searches relevant for this paper included “birth asphyxia/asphyxia neonatorum,” “hypoxic ischaemic encephalopathy/hypoxic ischemic encephalopathy,” “neonatal encephalopathy,” or “neonatal mortality,” and a combination of “TBA/trained TBA/traditional birth attendant,” “community health worker/village health workers/community health aides,” “birthing center,” “skilled birth attendant/skilled attendant,” or “community midwives OR midwifery.”

Modified GRADE criteria were used to evaluate the quality of the evidence [15] (strong, moderate, low, or very low) and give a

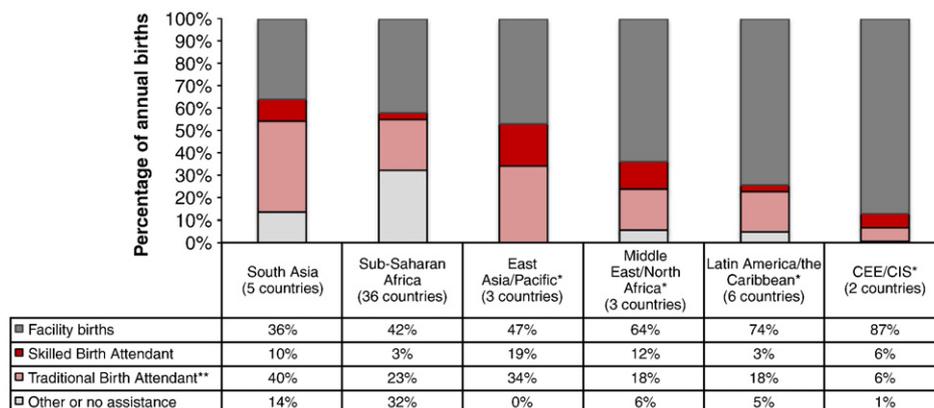


Fig. 1. Coverage of care for facility and home births according to birth attendant. Source: New analysis based on data from UNICEF [1] 2009 and Demographic Health Surveys (2000–2007). Percentages are the weighted averages for countries with data on facility birth, skilled birth attendance, and TBA attendance at deliveries. Facility births presume skilled attendant at birth. Coverage of skilled birth attendance outside of facility is the difference between skilled attendant and facility birth coverage. * The regional data shown is higher than actual regional averages for home births because we are using weighted averages for countries with information by country from DHS, which are not administered in all countries. Thus, this information is not representative of these regions. ** Traditional birth attendant includes both trained and untrained TBAs for 4 countries that have DHS data on trained TBAs: Ghana, Niger, Tanzania, and Zimbabwe.

Table 1
Cadres of workers attending births in domiciliary settings.

Type of provider	Characteristics	Training	Skills
Skilled birth attendant (SBA)	An accredited health professional – such as a midwife, doctor or nurse. Live in and part of community served.	Midwifery skills with classroom and labor ward experience and competency-based examinations.	Manage normal labor and delivery, perform essential interventions, start treatment and supervise the referral for interventions that are beyond their competence [101] Skills for SBAs undertaking home births (WHO-SEARO) [102] <ul style="list-style-type: none"> • Active management of third stage of labor • IV infusion (antibiotics, anticonvulsants, oxytocics) • Management of postpartum hemorrhage • Manage convulsions in pre-eclampsia or eclampsia • Basic neonatal resuscitation • Recognize incomplete evacuation of placenta, cervical tears, uterine rupture, bleeding, obstructed labor – stabilize and refer
Trained traditional birth attendant (TBA)	Community members who provide childbirth care; may range from family member attending only occasional births to women with considerable expertise attending 20+ births/year. Not usually salaried, often paid in-kind. Typically not civil servants or employed by Ministry of Health.	Community-acquired skills, and variable add-on training usually limited in time. Training may vary from a few days of non-focused didactic teaching to a carefully planned and targeted training scheme employing a competency-based approach and ongoing supervision and support. Factors likely to lead to success in training TBAs [58,82,83] include: careful selection criteria TBAs (for example, a consistent work load such as ≥20 births per year) and of trainers; careful design of training to address local practices and include practical procedures; incorporation of ongoing supervision; attention to relations with formal health system providers; and systematic approach to sustainable remuneration and social rewards.	<ul style="list-style-type: none"> • Social and cultural support • Clean delivery if trained • Not trained to manage obstetric complications but some evidence for recognition and referral for obstetric complications (highly debated)
Community health worker (CHW) (<i>Village health worker, Village health guide, Health extension worker, Community health volunteer</i>)	CHWs are selected, trained and work in the communities from which they come. May or may not be formally employed; health extension workers are government cadres.	Varies between countries. Initial training may vary from 12 days to 1 month, with ongoing refreshers and supervision.	<ul style="list-style-type: none"> • Link between community and health system • Preventive health measures • Birth preparedness • Clean delivery • Identification and treatment of minor illnesses (including IM injection with antibiotics, basic neonatal resuscitation with bag and mask)

recommendation for programmatic application (strong, weak, conditional), as detailed in an earlier paper in this series [2]. We use an adaptation of GRADE developed by the Child Health Epidemiology Reference Group (CHERG) specifically for low- and middle-income settings [16]. As our specific interest is for intrapartum-related (“birth asphyxia”) outcomes, this is a particular constraint as cause-specific data are limited.

Mortality reduction is reported as relative reduction unless otherwise reported. We conducted meta-analyses of studies evaluating packages of interventions provided by SBAs and CHWs using the Mantel-Haenszel (MH) pooled relative risk (RR) and corresponding 95% confidence interval (CI). When significant heterogeneity was detected ($P < 0.10$), a random effects model was used to estimate the RR and CI. Studies were included if they reported the outcomes of interest (IPR-NMR, PMR, or ENMR). Meta-analysis of all-cause NMR was not conducted as most packages addressed multiple neonatal conditions, and the other mortality indicators may more specifically reflect the burden of intrapartum-related events in the absence of cause-specific mortality data. Higher quality studies were included and considered for pooling risk estimates if the study design was a randomized controlled trial (RCT) or quasi-experimental study. In the absence of high-quality studies, observational studies of lower quality were considered for meta-analysis if the intervention, study design, and the outcomes of interest were comparable. However, historic or ecologic data were excluded. All analyses were conducted using STATA 10.0 statistical software (StataCorp, College Station, TX, USA).

3. Results for community-based strategies

3.1. Increasing skilled childbirth care in the community

3.1.1. Background

SBAs are defined by the United Nations as “medically qualified providers with midwifery skills (midwife, nurse or doctor) who have been trained to proficiency in the skills necessary to manage normal deliveries and diagnose, manage, or refer obstetric complications, ideally who live in, and are part of, the community they serve. They must be able to manage normal labor and delivery, perform essential interventions, start treatment and supervise the referral of mother and baby for interventions that are beyond their competence or not possible in a particular setting” [17] (Table 1). The core skills of the SBA include monitoring the progress of labor, augmenting labor, conducting normal delivery with aseptic technique, actively managing the third stage of labor, and newborn resuscitation [12]. Furthermore, WHO recommends that in remote areas with poor access to a health facility with capacity for surgical intervention, the SBA should be able to perform vacuum or forceps extraction, vacuum aspiration for incomplete abortion, and symphysiotomy for obstructed labor [12].

SBAs may provide domiciliary childbirth care in the home or in community birthing centers. Community birthing centers may range from a simple “maternity home” to a rural hospital that is staffed 24 hours a day by an SBA who provides basic emergency obstetric care (includes BEmOC, caesarean delivery and blood transfusion). This

strategy may or may not provide transport to comprehensive EmOC (CEmOC) (including cesarean delivery and blood transfusion) [18].

3.1.2. Evidence for skilled childbirth care in the community

Given that the SBA directly provides clinical care at the time of labor and delivery, s/he by definition performs procedures for both primary prevention (management of intrapartum care and monitoring or use of the partograph, capacity to perform basic interventions in the home, and referral of complicated cases to EmOC) and secondary prevention (assessment and management of the non-breathing baby, e.g. neonatal resuscitation). Table 2 summarizes the evidence for the effect of SBAs on intermediate outcomes and Table 3 outlines the effect on mortality.

3.1.2.1. Training, skills, and competency of community-based SBAs. While there is a core skill set for SBAs defined by WHO, the training and competency of SBAs in using these core skills varies substantially between settings and countries [19]. In Nepal and Bangladesh, SBAs were trained for as little as 6 months, yet have been found to have acceptable knowledge and competency [20,21] (Table 2). Studies in Zambia, Indonesia, and Vietnam have demonstrated improvements in knowledge and skills of midwives trained in essential newborn care and obstetric life-saving skills [22–25]. However, an assessment of SBAs in Benin, Rwanda, Kenya, Ecuador, and Jamaica demonstrated poor retention of knowledge and skill competency; only half of SBAs displayed competency to deal with specific obstetric and neonatal complications [19]. Competency and skill retention of providers are major concerns for SBAs, particularly those practicing independently in the community and conducting advanced procedures, emphasizing the need for adequate supervision and monitoring of competency.

Monitoring the progress of labor is a core skill for SBAs, and the partogram has been used effectively by midwives in community settings and birthing centers [26]. In North Sumatera Province, Indonesia [27], training midwives in use of the revised WHO partograph resulted in a lower proportion of labor augmentation (adjusted odds ratio [aOR] 0.21; 95% CI, 0.12–0.36), obstructed labor (aOR 0.38; 95% CI, 0.15–0.96), higher rates of referral for crossing the partograph alert line (aOR 4.23; 95% CI, 2.1–8.1), and lower proportions of infants with Apgar scores of less than 7 at 1 minute (aOR 0.45; 95% CI, 0.26–0.79). However, there was no significant improvement in 5-minute Apgar scores or need for neonatal resuscitation. The use of the partograph in facility settings is discussed further in paper 2 of this series [4].

3.1.2.2. Community midwives: Intrapartum-related mortality effect. In Matlab, Bangladesh, a community-based maternity care program was instituted in 1987 in an intervention area, to increase coverage of skilled midwives for home births to monitor the progress of labor, administer medications for pre-eclampsia, and manage malpresentation (Table 3) [28,29]. The intervention area also had a basic obstetric care facility, and referral-transport mechanisms (speedboat and ambulance) to transfer mothers with labor complications. The comparison area received routine government services. Obstetric mortality was reported to be 65% lower in the intervention area compared with the government-served comparison area [28]. However, subsequent re-examination of the data revealed that the maternity mortality rate (MMR) had declined to a similar level without the intervention in the southern comparison area of Matlab, possibly due to increasing access to EmOC through other sources, and better family planning [30]. During the period of SBA-assisted home births (1987–1996), in the intervention areas, 27% of women gave birth with a SBA compared with 4% in the comparison area [29], and the crude SBR and IPR-NMR were significantly lower in the community midwife-served versus comparison areas (crude OR for SBR 0.85; 95% CI, 0.76–0.94; crude OR for IPR-NMR 0.78; 95% CI, 0.64–0.95). Beginning in 1996, there was a gradual shift from skilled home births to facility-based care in all of Matlab [31].

Indonesia is a well-known example of a nationwide scale up of community-based midwifery services since the late 1980s. The national MMR declined from 400 (in 1989) to 300 per 100 000 births by 2003, and all-cause neonatal mortality was reduced from 32 to 20 per 1000 live births [10]. However, an analysis of Demographic Health Services (DHS) data reported that, while ENMR decreased 3.2% annually over the time period, there was no significant change in the rate of decline after the village midwife program was initiated. Furthermore, the adjusted risk of first-day and early neonatal deaths was not significantly different between midwife-attended versus unattended births [32]. Rapid recruitment of midwives may have resulted in acceptance of candidates with lower qualifications and less clinical training than expected for SBAs [10]. Furthermore, there was limited mentorship, ongoing training, or incentives for retention, as well as inadequate linkages to effective EmOC. In 2003, in a pilot program, midwives in the Cirebon district were additionally trained in the identification and resuscitation of newborns using a tube-and-mask apparatus [33]. The specifics of neonatal resuscitation training and content are described in the third paper in this series [5]. Over the study period, midwives successfully managed 85% of cases of non-breathing babies and there was an approximate reduction in IPR-NMR of 47% based on estimated crude birth rates (IPR-NMR 5.1 per 1000 before training to 2.7 per 1000 after training).

In Khartoum, Sudan, community-based midwives were trained to conduct pregnancy surveillance and pregnancy monitoring (blood pressure, presence of edema, weight gain), birth planning for newborn care, and to refer to the central hospital for obstetric emergencies. A key component was linking the village midwife to the primary healthcare system and mobilizing pregnant women to seek pregnancy care. Over the 3-year period, the PMR was significantly reduced by 25% [34]. In Ghana, community midwives were trained in the use of the partograph and emergency obstetric skills and partnered with TBAs for referrals of obstetric emergencies; however, while there was a trend in reduction of PMR, the change was not statistically significant [35].

3.1.2.3. Birthing centers: Intrapartum-related mortality effect. In West Java, Indonesia, Alisjahbana et al. [36] evaluated the effect of village birthing centers or “polinades” as part of a comprehensive maternal healthcare program from 1992–1993 (Table 3). Given the local cultural belief that the home provides a “life force” to save the mother in labor, birthing homes/centers were established in the community and promoted through social marketing to enable the provision of prenatal, childbirth, and postpartum services by resident SBAs. Emergency transport and communication systems with a district hospital were also implemented. The 1-year evaluation found that prenatal care with a skilled provider was significantly higher for the intervention than for the comparison areas and a significantly higher proportion of women who had prenatal complications delivered in a health facility (31% versus 11%). The proportion delivered by an SBA remained low (<15%), although the proportion with intrapartum complications who were delivered by a midwife or doctor was significantly higher in the intervention area (14% versus 3%). There was no difference in PMR between the intervention and comparison areas; however, the baseline PMR in the control area was lower than the intervention area and the study was inadequately powered. Within the intervention area the PMR fell from 50 to 37 per 1000 over the study period.

In China in the early 1980 s, birthing centers (maternal-child health centers) in rural Shunyi province [36] were staffed by village doctors or midwives who monitored and managed hypertensive disorders and conducted external cephalic version for breech, and referral of high-risk women to deliver at the county hospital. Over a 4-year period, PMR was reduced from 26.7 per 1000 births (1983) to 17.6 per 1000 births (1986) (relative risk [RR] 0.65; 95% CI, 0.44–0.98) and perinatal deaths attributed to an intrapartum hypoxic event were reduced from 4.1 to 3.0 per 1000 births.

Malaysia made universal skilled birth attendance a national priority from the time of independence (1957), and achieved this by making the

gradual transition to skilled care at home with community midwives and then to birthing homes and institutions by using TBAs as partners. Benefits of the birthing center included shorter travel distance, the presence of female staff, and companionship/support from husbands, relatives, and/or TBAs [37]. Historical data suggest an 80% reduction in NMR over two decades when birthing homes and community availability of skilled childbirth care were introduced [38,39]; however, many other interventions (e.g. economic growth) and social changes may have contributed.

3.1.2.4. Effect of community skilled birth attendance on intrapartum-related mortality: Meta-analysis. We did not identify any high quality RCTs of SBAs in the community. There were 2 quasi-experimental studies with a non-randomized comparison group; however, in these studies the comparison group had either different baseline characteristics [40] or contamination by the intervention in comparison areas [30]. Thus, we used the before-and-after data from intervention areas for these trials. We found 4 studies with observational before-and-after data on training community SBAs for which we conducted a meta-analysis, and showed a 12% reduction in PMR (RR 0.88; 95% CI, 0.83–0.95) (Fig. 2A) and a 13% reduction in ENMR (RR 0.87; 95% CI, 0.79–0.97) (Fig. 2B). Excluded studies were the Matthews study [35] because of the large component of TBA training and the PATH study [33] that focused primarily on additional neonatal resuscitation training and estimated the number of births based on crude birth rates. Three studies reported IPR-NMR; however, the definitions of “birth asphyxia” varied across studies and the study designs and interventions were heterogeneous and thus the results were not pooled.

3.1.3. Cost of care by SBAs

An economic evaluation of the community-based midwifery training component of the South Kalimantan MotherCare project in Indonesia in the 1990s estimated training costs of between US \$1214 and US \$1694 per trainee (including life-saving skills training, continuing education, and internship), who performed an average of 3.3–5.5 births per month; 68% of costs were attributed to technical assistance and central administration [41]. The incremental cost was US \$5651.5 per 1% increase in the number of competent midwives.

Training of community midwives in Cirebon, Indonesia in post-natal care and neonatal resuscitation cost Rp 2375 (US \$0.25) per baby delivered over a 5-year period, with a cost of US \$42 per intrapartum-related neonatal death averted [33]. One possible lower cost model is the South African Perinatal Education program, which, through long distance self-education, has been shown to increase knowledge and skills at a direct cost of US \$5 per trainee, although running costs are not reported [42–44].

3.1.4. Implications

The quality of evidence that skilled birth attendance in the community may improve perinatal outcomes is low by GRADE criteria, primarily from observational, before-and-after or historical studies (Table 4). A meta-analysis of observational before-and-after data from 4 studies of SBA training showed a 12% reduction in PMR and a 13% reduction in ENMR. However, this effect size should be interpreted with caution as it may underestimate the potential impact of community-based SBAs, since some of these studies reflect the effect of “additional” training, none of the studies clearly included neonatal resuscitation with bag and mask and, moreover, in these community settings it is often the more complicated cases who seek skilled care, reflecting a higher-risk population. The quality of data on intrapartum-related outcomes was heterogeneous and could not be combined; however, there was a reported range of 22%–47% reduction in mortality of the “non-breathing baby” in three studies. Despite the low-quality evidence, skilled childbirth care is strongly recommended for all pregnant women, and providing skilled birth attendance in the community may improve perinatal outcomes if properly linked with quality and expedient EmOC

(Table 4). Thus, bringing SBAs into and retaining them in the community is a potentially important strategy to reduce inequities in access to skilled childbirth care. Considerable program experience of birthing centers exists; the advantages include easy access for women and the possibility to maximize coordination between the SBA and alternative cadres.

There is a need to better delineate and evaluate what procedures may be competently performed by a skilled provider in the home versus facility setting. For example, while improved monitoring, referral for obstetric emergencies, and provision of neonatal resuscitation may be reasonably conducted in the community, few data exist regarding complex procedures such as vacuum extraction or symphysiotomy. Some experience with community-based BEmOC in Burma [45] is further discussed in the second paper in this series. In many cases of obstructed labor, surgical delivery is required to save the lives of the mother and infant, and requires a functioning continuum of care from the community to facilities [6]. Thus, if community-based SBA training is undertaken, it should occur in parallel with and be linked to improvements in the quality and supply of facility-based intrapartum CEmOC; and outcomes should be carefully monitored. Important issues to be considered in community-based SBA programs include how to retain SBAs in rural communities, and how to maintain their skills with sufficient workload. In certain settings, particularly isolated communities with clusters of more densely populated villages, allowing the placement of several midwives in a birthing center may be a feasible and cost-effective approach to reducing fetal, neonatal and maternal deaths from complications in labor provided training costs are controlled. More research, including outcome evaluation and economic analysis, and the effect of financial incentives on care seeking for skilled community-based childbirth care, is urgently needed.

3.2. Training TBAs for providing labor and childbirth care

3.2.1. Background

TBAs have attended births for women delivering at home since time immemorial [46], and following the Alma Ata Declaration in 1978, WHO actively promoted the legalization and training of TBAs. By 2000, 85% of low-income countries had a TBA training program. During the 1990s, however, WHO policy moved to emphasize the importance of skilled birth attendance, and TBAs were to be “integrated into the system.” In 2004, TBAs were excluded from the category of providers identified by “skilled birth attendance” [47].

The role, skills and training of TBAs vary widely between settings (Table 1). Here we focus on trained TBAs, given the lack of evidence evaluating the effect of family members and untrained TBAs on maternal and neonatal outcomes. The focus of early training programs was on clean delivery and maternal health outcomes, and one authority stated that a TBA’s “status in the community depends on her ability to manage complicated cases without endangering the mother’s life, the baby being considered less important” [14]. If the mother lives and the baby dies, the community may express gratitude for saving the mother’s life while minimizing any blame for the newborn’s death [48]. However, in the 1980s there was increased interest in specialized training for neonatal resuscitation and the focus has shifted more recently to include newborn outcomes, South Asia, since attention given to both mother and baby is more cost-effective [49–51].

3.2.2. Evidence for the effectiveness of training TBAs

While the majority of the early published literature with regard to TBAs was descriptive, more recent studies have addressed changes in knowledge and attitudes following training, and several have assessed changes in behaviors, including referrals [52–56]. There are few studies, however, of the effect of training on maternal or perinatal mortality or serious morbidity [50,56–61]. Lack of evidence for the effect of TBAs on maternal and perinatal mortality has perpetuated the debate on their

Table 2

Evidence for community midwives and birthing centers: Intermediate outcomes 2005–2008.

Intervention/study	Setting	% skilled attendance	Changes in knowledge/attitudes	Changes in care seeking/demand	Other intermediate outcomes	Investigator and year
Non-randomized comparison of delivery procedures and outcomes at Patan Hospital Birth Center(BC) staffed by mid-wives vs consultant led-maternity unit (CMU).	Patan Hospital, referral hospital for urban Lalitpur, (Kathmandu valley) Nepal	87%		<ul style="list-style-type: none"> Mothers attending BC were more likely to attend postnatal care clinics (33%) and access family planning services 	<ul style="list-style-type: none"> Mothers attending BC had significantly lower risk of cesarean (63%), episiotomy (36%), meconium (38%), and oxytocin augmentation (73%) BC deliveries had higher likelihood of artificial rupture of membranes (26%) No significant differences in delivery complications, birth weight, Apgar score, or special care unit between BC and CMU 	Rana et al. [26] 2003
Quasi-experimental study assessing impact of Life-Saving Skills (LSS) training and strengthening of maternity facilities on labor management in clinics and hospitals	Lam Dong Province, South central Vietnam	Not stated			<ul style="list-style-type: none"> Increased detection of obstetric emergencies in LSS trained hospital and clinic settings Substantially improved management of obstetrical emergencies in LSS trained hospital facilities, but not in LSS trained clinics 	Sloan et al. [25] 2005
Training of Bidan di Desa (village midwives) in neonatal care, including management of the non-breathing baby with neonatal resuscitation using tube-and-mask resuscitators. Refresher 5 minute video distributed with tube-and-mask devices. Before and after comparison of midwife knowledge, observed skills and neonatal mortality rates.	Rural Cirebon, West Java Indonesia	20% deliver in health facilities Skilled attendance rate not reported	<ul style="list-style-type: none"> Increase in midwife knowledge post training No significant reduction in knowledge or skills 9 months post training 		<ul style="list-style-type: none"> Increase in observed skills performing resuscitation In 1 year, 466 cases of BA managed by 274 (65%) of midwives trained; 377 (85%) of asphyxiated infants were resuscitated and survived (70% with basic resuscitation 26% with positive-pressure ventilation) 	Ariawan [33] PATH 2006
Retrospective observational study of neonatal outcomes before and after Obstetrics Emergency Training of midwives and obstetricians in tertiary care hospital, including cardiocograph. Training included cardiocograph tracings, electronic fetal monitoring, obstetric emergencies, and neonatal resuscitation.	Tertiary Care Hospital in Southmeade, England	100%			<ul style="list-style-type: none"> Statistically significant reduction in hypoxic ischemic encephalopathy (RR 0.50) and 5 minute Apgar <6 (RR 0.51) Significant increase in rate of emergency cesarean delivery (9.35% pre, 11.4% post) No change in stillbirth rates 	Draycott et al. [103] 2006
Evaluation of training of midwives in low risk clinics in WHO Essential Newborn care course, including newborn resuscitation training. Pre-post training written and performance testing.	Urban Lusaka and Ndola, Zambia	43%	<ul style="list-style-type: none"> Significant improvement in mean written knowledge test (pre-course 65, post-course 77) Resuscitation was an area of greatest improvement; Knowledge of indications for resuscitation doubled post training (27 vs 54%) 		<ul style="list-style-type: none"> Significant improvement in observed performance evaluations after course (65 vs 84) 	McClure et al. [23] 2007

Evaluation of knowledge, skills and competency of village mid-wives attending in service training program, internship program vs those receiving no training. Training program included the American College of Nursing-Midwifery Life Saving Skills for Midwives, partograph use, and neonatal resuscitation	Rural South Kalimantan province, Indonesia	Not stated	<ul style="list-style-type: none"> Significantly improved knowledge in trained midwives regarding antepartum and intrapartum care 	<ul style="list-style-type: none"> Significantly improved scores for neonatal resuscitation (67 vs 32% skills; 61 vs 4% competency) and use of partograph (76 vs 66% skills; 82 vs 57% competency) in trained vs untrained mid-wives 	McDermott et al. [22] 2001	
Evaluation of Skilled Birth Attendant (SBA) training program piloted by Bangladesh MOH in 2003 (90 female health assistants trained). Focus groups, knowledge and competency tests conducted pre-post, and 6 months after training.	6 rural sub-districts Bangladesh Pop: 72,240	13%	<ul style="list-style-type: none"> 55% of SBA retained knowledge of content topics of training 	<ul style="list-style-type: none"> SBA's attended 33% of home births, provided 52% of prenatal care visits, 44% of postnatal care visits Each SBA performed 9–10 prenatal care visits, attended 2–4 births, and 3–5 postnatal care visits/month. SBA's made an average 137 referrals/month comprising 55% of hospital referrals 	<ul style="list-style-type: none"> Scored average of 75% on 9 essential skills of delivery/newborn care Scores on use and referral with partograph were high (80%–90%) 68% of SBA's could correctly demonstrate newborn resuscitation Skill retention during observed births was high [2nd stage 89%; 3rd stage 76%] Women treated by SBA's experienced lower rates of problems/complications during pregnancy compared to those by TBA's (14% vs 34%) 84%–90% of beneficiaries were satisfied by their service, and 60% planning for their next pregnancy would prefer SBA Competence to correctly use partograph ranged from 50%–66% Competence in neonatal resuscitation skills using ambu-bag ranged from 40–68% 	Bhuiyan et al. [20] 2005
Assessment of knowledge and skills of 166 skilled birth attendants from Benin, Ecuador, Jamaica, and Rwanda (Phase 1); and 1358 from Nicaragua (Phase 2). Competence guidelines developed from WHO Integrated Management of Pregnancy and Childbirth (IMPAC).	Phase I: Benin, Ecuador, Jamaica, Rwanda Phase II: Nicaragua	31%–96%	<ul style="list-style-type: none"> Overall knowledge of SBA's ranged from 48%–62%. Active management of 3rd stage of labor knowledge scores ranged from 7.4%–74% Knowledge of immediate newborn care ranged 44%–66% 	<ul style="list-style-type: none"> Competence to correctly use partograph ranged from 50%–66% Competence in neonatal resuscitation skills using ambu-bag ranged from 40–68% 	Harvey et al. [19] 2007	

Table 3
Evidence for impact of community midwives and birthing centers: Mortality effect.

Intervention/study	Setting	% skilled attendance	Baseline mortality rates	Mortality effect: % Relative Reduction in Mortality Rate (number of deaths in intervention or end-line group); RR or OR (95% CI)					Investigator and year
				SBR	ENMR	PMR	NMR	IPR-NMR	
Before-and-after study of training village midwives and doctors at rural maternal primary health centers. Trained to manage-monitor pregnancy-delivery (blood pressure monitoring, external cephalic version), refer high risk mothers to county hospital. High risk pregnancies screened and booked at county hospital.	Shunyi, China	NS	PMR 26.7		23% OR 0.77 (0.43–1.36)	34% OR 0.66 (0.44–0.98)		27% ^a (7)	Yan et al. [36] 1989
Before-after study of training and upgrading of skills of village midwives (antenatal care, monitoring in labor, referral of high risk births, post natal care). Also established referral-transport system.	Khartoum, Sudan	1985–1988 9% in health facility, 91% of home births attended by midwives	SBR 23 PMR 44 NMR 27	15% (48) RR 0.85 (0.60–1.19)	22% (34) RR 0.78 (0.61–1.01)		32% (44) RR 0.68 (0.48–0.97)		Ibrahim et al. [34] 1992
Quasi-experimental comparison of comprehensive package of traditional birth attendant (TBA) training, village birthing homes with skilled attendants, capacity building in facilities and strengthening facility-community transport links in intervention vs a comparison district.	Indonesia Sub-district rural West Java Intervention (90 000) area Control (40 000) area	< 15%	PMR 50			25% ^b (44) RR 0.75 (0.51–1.10)	-	-	Alisjahbana et al. [40] 1995
Quasi-experimental non-randomized comparison of maternal mortality for two control areas (north and south) and one intervention area (north) in Matlab after institution of a community-based maternity care program (two health centers, four midwives and a speedboat).	Bangladesh, rural (Matlab)	Intervention area (MCH-FP) Control area	SBR 39.8 ENMR 39 NMR	15% ^c (622) OR 0.85 (0.76–0.94)	17% ^c (542) OR 0.83 (0.75–0.93)		22% ^d OR 0.78 (0.64–0.95)	50% ^e	Fauveau et al. [28] 1991 Ronsmans et al. [104] 1997 Ronsmans et al. [29] 2008 MOH Malaysia 1998
Historical data of national prioritization of the reduction of maternal mortality ratio (MMR) with inter-sectoral approaches including birthing centers and increased skilled attendance.	Malaysia	1970 'majority at home with TBA' 1980 'majority at home with skilled attendant'	1957 NMR 75.5	-	-		80% (1957 to 1980) ^f		Koblinsky [38] 1999
Historical data of training midwives in home based delivery including use of forceps in 1829 in Sweden.	Sweden	Sweden 1829 73% home delivery	PMR 42			29% ^g 0.71 (0.62–0.82)			Andersson et al. [105] 2000

Quasi-experimental non-randomized comparison of a total of 4169 women in 3 randomly selected communities one with no trained TBAs, one with trained TBAs and one with good access to functioning maternities (nurses and midwives). Before-after study of training rural midwives in use of partograph and emergency obstetric skills. Also training of TBAs to recognize and refer danger signs. Emergency obstetric transport service established. Before-after study of training of Bidan di Desa (village midwives) in neonatal care, including management of birth asphyxia with neonatal resuscitation using tube mask resuscitators. Refresher 5 minute video distributed with tube mask devices. Observation of midwife knowledge, skills and mortality rates. Historical data on national Ministry of Health training program of village midwives starting in 1989. Training of 54,000 village-based midwives with 96% of population with access. Historical evaluation of Demographic Health Services (DHS) data during Village midwife training program started in 1989, by 1995 50,000 trained. In 1996 competency based training program including neonatal resuscitation.	Mozambique rural	Varied by community from ~40% to 77%	NMR 12–15 SBR 15–22	No difference ^h detected OR 1.43 (0.69–2.93)		No difference detected OR 1.24 (0.52–2.89)	-	Gloyd et al. [106] 2001
	Rural Brong Ahafo, Ghana	~30%	PMR 26		No diff detected OR 0.69 (0.33–1.45)			Matthews et al. [66] 2004
	Rural Cirebon, West Java Indonesia Pop: 2 million	20% deliver in health facilities Skilled attendance rate not reported	NMR 15 SBR 8 PMR 21 IPR-NMR 5.1	No significant change Baseline 8/1000 End-line 6/1000	29% ⁱ	40% ⁱ	47% ⁱ	Ariawan, PATH [33] 2006
	Indonesia, national level	22% at baseline	NMR 32 MMR 400			37% ^j		Shankar et al. [10] 2008
	Indonesia, national level	12% midwife attended in 1986					No difference detected RR 0.98 (0.95–1.02) per year reduction	Hatt [32] 2009

Abbreviations: SBR, Stillbirth Rate; ENMR, Early Neonatal Mortality rate; PMR, Perinatal Mortality Rate; NMR, Neonatal Mortality Rate; IPR-NMR, Intrapartum-related Neonatal Mortality Rate. ^a Authors report perinatal mortality attributed to “asphyxia,” but not clearly defined. 95% CI not given. ^b Baseline PMR in control area lower than intervention area and no significant change with time so intervention/control results not used. Before-after data used. Non-significant comparison between first 6 months and second 6 months in intervention area. ^c Comparison of ICDDRB vs Government service areas in years 1989–1995, crude non-adjusted rate comparison. ^d Effect was not not significant versus southern control area where EmOC access increased. ^e Comparison of ICDDRB vs Government service areas in years 1987–1999. ^f Historical data and should be interpreted with caution as many other factors may have influenced the reduction, 95% CI not given. ^g Historical comparison (1891–1899) of midwife attended vs non-attended births controlling for some confounding factors. ^h Comparison of skilled birth attendant in midwife served area vs trained TBA served area, non-random allocation. ⁱ Reported significant change ($P < 0.05$), no CIs given; number of births estimated based on crude birth rate that was not measured. ^j Historical data and should be interpreted with caution as many other factors may have influenced the reduction, 95% CI not given.

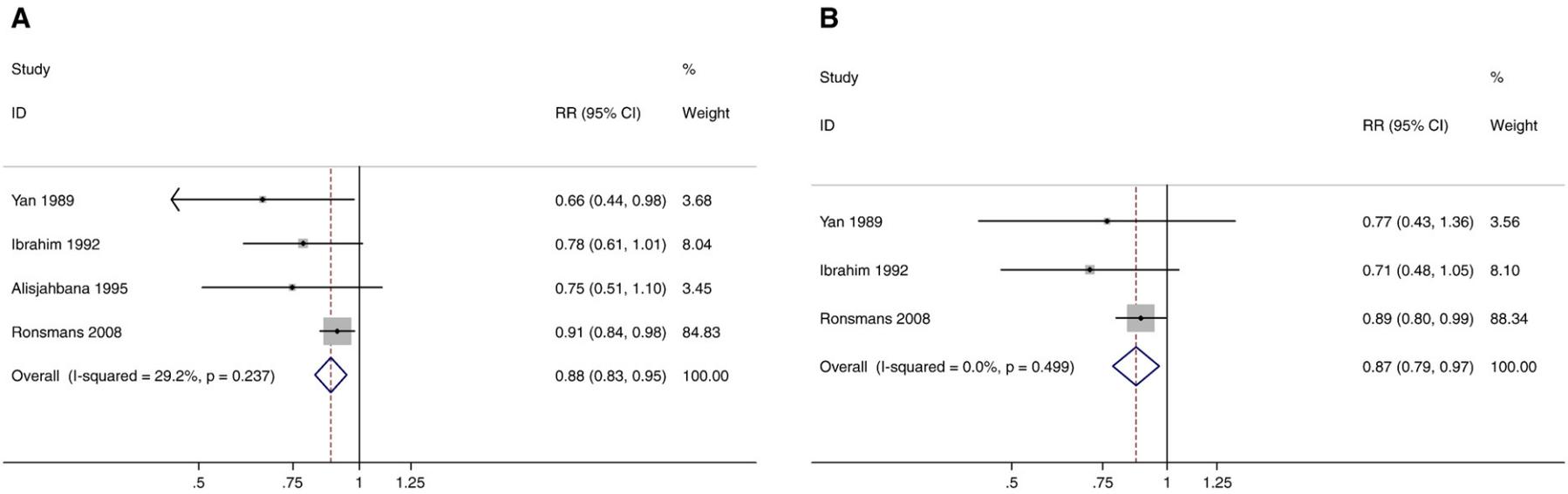


Fig. 2. Meta-analysis of mortality effect with before/after evaluations of community-based skilled birth attendants. (A) Perinatal mortality. (B) Early neonatal mortality rate.

Table 4

Interventions reviewed: Evidence grade, feasibility, and recommendations.

Intervention	GRADE Evidence Level	GRADE Recommendation	Feasibility in LIC-MIC
Skilled Birth Care in the Community: Skilled Birth Attendants (SBAs) or in Birthing Centers	LOW: We identified 3 quasi-experimental, 4 observational before-after, and 4 historical studies of skilled birth care at the community level. The data is inconsistent, as not all studies demonstrated a benefit. In a meta-analysis of before-and-after data from 4 low-quality studies of community midwife training there was a 12% reduction in all cause perinatal mortality. There is limited poor-quality data on effect on intrapartum-related neonatal mortality rate (IPR-NMR), as different definitions are used and likely include preterm mortality; the reported effect ranged from 22%–47% reduction in IPR-NMR. Most studies were set in low- and middle-income settings, primarily Asia, and may be generalizable to similar settings.	STRONG: Skilled childbirth care is recommended for all pregnant women, and there is low quality evidence that providing skilled birth attendance in the community may improve perinatal outcomes, if properly linked with quality and expedient emergency obstetric care. It would be unethical to conduct randomized controlled trials (RCTs) for skilled birth attendance. However, the quality of evidence is low, primarily observational before-after or historical studies; better monitoring and evaluation of the impact of SBA training programs is urgently needed.	Successful program experience and national scale-up in Indonesia, Bangladesh, Malaysia. In many settings, may not be feasible where there are human resource shortages. Large-scale national initiative on auxiliary nurse midwives failed to ensure SBA availability at delivery in India. Need to evaluate competency and capability of SBAs to perform basic emergency obstetric care (BEmOC) procedures in home settings vs facility. Requires close monitoring, evaluation, and need for frequent retraining.
Trained Traditional Birth Attendants (TBAs) partnering with the health system	LOW: There is one cluster RCT that TBA training may improve linkages with facilities and improve perinatal outcomes, although intrapartum-specific data is not available. There is evidence from a meta-analysis that TBA training may reduce perinatal-neonatal mortality by 6% and intrapartum-related mortality by 11%, from primarily low-quality studies. The data is generalizable to low-middle income settings.	CONDITIONAL: The role of the TBA is still controversial, but there is some evidence that the TBA may partner with the health system, detect obstetric complications, refer to skilled obstetric care and positively impact stillbirths and neonatal outcomes. TBAs still attend up to 40% of home births in certain regions where skilled attendants are inaccessible, and their potential role as a facilitator with the health system should be further refined and rigorously evaluated.	Mixed program experience in the past, and history of controversy. While TBA does not equal a SBA, recent experiences have effectively used TBAs to link pregnant women with the formal health system, and may be feasible to include in collaborative partnership. Need to understand local culture, customs and practices surrounding childbirth.
Integrated Community Health Worker (CHW) Packages	MODERATE: There are 2 cRCTs and 2 quasi-experimental studies that have demonstrated the positive impact of CHW packages on perinatal-neonatal outcomes. A meta-analysis of these studies show a 36% reduction in early neonatal mortality. One quasi-experimental study showed a 42% reduction in IPR-NMR over time.	STRONG: The evidence is growing that CHW packages may be effective in improving perinatal outcomes, and this is a relatively low cost mechanism of providing care for the poor and marginalized in community settings in LMIC. There is a need for the evaluation of the impact of CHW packages on intrapartum-specific mortality and long term outcomes, and to also for further implementation research.	Feasible in several small-scale trials, need to be tested for sustainability and scalability, as well cost-effectiveness. Programs may be started with relatively low cost.

Table 5

Evidence for traditional birth attendant (TBA) training: Intermediate outcomes 2005–2008.

Intervention/study	Setting	% skilled attendance	Baseline mortality rates	Changes in knowledge/attitudes	Changes in care seeking/demand	Other intermediate outcomes	Investigator and year
Meta-analysis on relationship of TBA training (health promotion, disease prevention, clean birth practices) and use of professional antenatal care (ANC). Lack of adequate information about TBA training program characteristics.	15 studies from 8 countries, Africa and Asia	–	–	• TBA knowledge about ANC significantly increased by 157% in trained vs untrained TBAs (baseline 28%)	• Significant increase in maternal compliance and ANC attendance rates by 38% (baseline 42%)	• TBA behaviors (advice and assistance) supporting ANC use significantly increased 47% in trained vs untrained TBAs (baseline 41%)	Sibley et al. [63] 2004
Meta-analysis of effectiveness of TBA training and access to skilled birth attendance. Overall poor quality of studies, TBA training was often a component of intervention packages in several studies.	16 studies from 12 countries in Asia, Africa and Latin America	–	–	• No statistically significant effect of TBA training on TBA knowledge related to referral	• Small, positive significant 22% increase in maternal compliance with TBA referral or maternal use of health facility. [Small subsample 2 studies]	• Small, positive, significant 36% increase in TBA behavior related to referral vs baseline	Sibley et al. [64] 2004
Home-based Lifesaving Skills (HBLSS) Program (obstetric first aid skills) training for TBAs. Evaluation of second phase of training.	Rural Liben Woreda, Ethiopia ~33 000	10%				• HBLSS trained TBAs attended 24–26% of births • Estimated exposure of 54% of pregnant women to HBLSS • 78% increase in TBA performance scores for “first actions” for neonate including basic resuscitation, with 9% reduction after 1 year • Management of “first actions” by women and families was significantly higher in births attended by HBLSS guide (55% vs 32%)	Sibley et al. [68] 2006

role [46,62] and also reflects the methodological and logistic challenges of systematic outcome assessment in such settings, particularly of measuring maternal mortality. There are several published systematic reviews of TBA effectiveness [63,64]. In this section we present data on intermediate outcomes of relevance (Table 5) and evidence for effect on mortality, particularly intrapartum-related outcomes (Table 6).

3.2.2.1. Trained TBAs for the primary prevention of intrapartum-related mortality. Evidence for benefit of TBAs in primary prevention of intrapartum-related hypoxia fits into two main categories: their role in augmenting use of routine prenatal pregnancy care, and intrapartum recognition and referral for obstetric complications.

A meta-analysis by Sibley et al. [63] included 10 studies (4919 and 3368 women in pooled treatment and comparison groups, respectively) and found that TBA training was associated with a significant 38% increase in use of prenatal services (Table 5). In Ethiopia, a before-after study demonstrated that TBA training was associated with increases in the receipt of prenatal care (49% pre to 61% post), reduction in unsafe practices during delivery, and a significant decrease in the proportion of babies born requiring neonatal resuscitation (11% before vs 7% after) [65]. The reduction in the need for resuscitation indicates the effectiveness of primary prevention, although it is unclear whether this was mediated through improved prenatal or intrapartum care in this study.

Several programs have demonstrated the capacity of trained TBAs to recognize and refer for obstetric complications, but success may vary with TBA educational level or literacy, training program content, relationships with the formal health system, as well as accessibility and perceived quality of referral facility care. Illiterate TBAs have used pictographs in Ghana to identify danger signs in pregnancy and refer pregnant women with risk factors for skilled childbirth care with trends of increased referral post-training [35]. In another study in India, however, there was no significant difference in TBA referrals of mothers for health center delivery based on identification of 1 or more pictorially-represented complications [66]. In Ethiopia, TBAs were trained in the Home-based Lifesaving Skills (HBLSS) program [67], including recognition of prolonged labor for purposes of primary prevention. Eighty-five TBAs participated in training on “birth delay” and displayed a 108% increase in post-training scores over the pretraining values ($P < .001$) [68] (Table 5).

Little data exists on the effect of TBA training on timing to referral and receipt of referral-level care in case of complications. In rural Fortaleza, Brazil, where a TBA training program was begun in the mid-1970s [58], TBAs conducted 55% of births and were able to recognize labor complications and effectively refer mothers with high obstetric risk (antepartum factors or intrapartum complications) for hospital delivery. There was a significant increase in referrals after training [58]; almost 50% of women at hospitals with complications during delivery had been referred by TBAs, and TBAs referred an average of 12% of pregnant women for hospital delivery, primarily for obstructed labor (40%), primiparity (12%), abnormal presentation (9%), and maternal hemorrhage (7%). The program has not been replicated, however. In Ghana, in a random survey of 1961 TBAs, training was associated with significant reductions in intrapartum fever, which has been linked to neonatal encephalopathy [69].

A program in Guatemala used a controlled, before-and-after design to examine the effect of a 3-month hospital-based training program for TBAs on rapid recognition and referral of complications [56]. TBA training was part of a comprehensive program including referral and facility improvements. There was a significant increase in overall referrals in both intervention and control areas, and no differences between the areas. In the intervention communities, there were 16 perinatal deaths ($n = 72$ births) versus 24 deaths ($n = 203$ births) before-and-after the intervention, respectively, corresponding to a significant decrease in death rate from 22% to 12% (OR 0.47; $P = 0.032$). However, there were no significant differences for identification and referral of conditions plausibly related to PMR or NMR (e.g. preterm labor, mal-

presentation, prolonged labor). Because women attended by TBAs who were not referred or who did not comply with referral were not included in the analysis, the effect of TBA training on extent and effect of referral on PMR in the study communities is unknown [70].

Sibley et al. [64] conducted a meta-analysis in 2004 of 13 studies assessing the effect of trained TBAs on referral practices for obstetric emergencies. Six studies included outcomes on TBA knowledge related to referral ($n = 441$ treatment vs $n = 786$ control), 13 studies included outcomes on TBA referral behavior ($n = 5976$ treatment vs $n = 5991$ control), and 2 studies reported outcomes on maternal referral behavior ($n = 812$ treatment vs $n = 1567$ control). Although TBA knowledge of conditions requiring obstetric intervention was not significantly affected by training, TBA behaviors related to obstetric referral (including detection and referral of intrapartum complications) showed a small, significant increase after training: 36% over baseline (13 studies with $n = 5976$ treatment vs $n = 5991$ control). Women seen by trained TBAs had a small, significant increase in obstetric care seeking behaviors (22%). The authors concluded, however, that given the overall insufficient quality of the studies and the fact that the interventions were included within packages of services, it was not possible to attribute the small improvements in TBA and maternal behaviors to the TBA training interventions alone.

In a large, cluster-RCT (cRCT) in Sindh, Pakistan, training and integrating TBAs into the health system to provide obstetric care resulted in substantial increases in detection and referral for EmOC, as well as significant reductions in PMR and NMR [61] (Table 6). A total of 585 TBAs were trained to recognize obstetric emergencies and refer for EmOC, encourage care seeking, use clean delivery kits, and promote essential newborn care. The partnership between the TBAs and lady health workers (LHWs), and links with the formal health system, was strengthened by increasing the frequency and quality of their contacts during birth kit distribution and at community based clinics within the community. The home birth rate was about 80% in both study arms, but trained TBAs attended the majority of births in intervention clusters (75%), whereas untrained TBAs attended most births in the control clusters (76%). Pregnant women attended by trained TBAs were less likely to have puerperal sepsis (RR 0.17; 95% CI, 0.13–0.23) and hemorrhage (aRR 0.61; 95% CI, 0.47–0.79), and more likely to be diagnosed with obstructed labor (RR 1.26; 95% CI, 1.03–1.54) and referred for EmOC (RR 1.50; 95% CI, 1.19–1.90). Early recognition and referral for obstructed labor, in addition to the reduction in significant risk factors for intrapartum-related injury, would presumably reduce the IPR-NMR in the intervention group. PMR was reduced by 30% in intervention clusters (OR 0.70; 95% CI, 0.60–0.80), SBR was reduced by 31% (OR 0.69; 95% CI, 0.57–0.83), and NMR by 29% (OR 0.71; 95% CI, 0.62–0.83). The study was not sufficiently powered to detect a reduction in MMR (OR 0.74; 95% CI, 0.45–1.23). Intrapartum-related mortality was not determined; however, the significant reduction in both stillbirths and early deaths in parallel with the previously discussed intermediate outcomes suggests that the intervention successfully targeted the primary prevention of intrapartum injury. However, scale-up remains a challenge.

3.2.2.2. Trained TBAs for secondary prevention: Recognition and management of the non-breathing baby. The evidence for beneficial involvement of TBAs in the management of the non-breathing baby is discussed in detail in the third paper on neonatal resuscitation [5], and will only be discussed briefly here. In the 1980s, Daga et al. [71] trained TBAs (attended >90% of births) in essential newborn care including mouth-to-mouth resuscitation of non-breathing infants. Over the program period, the PMR fell from 74.8 to 28.7 (1987–1990); however, also reflected were concurrent improvements in the management of low birth weight, preterm infants, and infections as well as improvements in hospital-based neonatal care. In Chandigarh, India, TBAs were trained to recognize the non-breathing baby and conduct neonatal resuscitation, using mouth-to-mouth and then bag-and-mask resuscitation (Table 6)

Table 6
Evidence for impact of trained traditional birth attendants (TBAs): Mortality effect.

Intervention/study	Setting	Percentage skilled attendance	Baseline Mortality Rates	Mortality Effect: % Relative Reduction in Mortality Rate (number of deaths in intervention or end-line group); RR or OR (95% CI)						Investigator and year
				SBR	ENMR	PMR	NMR	IPR-NMR	MMR	
Non-randomized comparison of perinatal outcomes between subset of TBAs trained in “advanced” resuscitation with suction and bag-and-mask as opposed to usual TBA training with mouth-to-mouth resuscitation.	Rural India	< 10%	PMR 49 IPR-NMR 5	-	-	19% ^a (45) RR 0.82 (0.56–1.19)	-	70% (5) RR 0.3 (0.1–0.8)	-	Kumar [54] 1995 Kumar [60] 1998
Before-after comparison of TBA training in basic resuscitation with mouth-to-mouth breathing.	Rural India	TBAs attend 90%	SBR 19 PMR 75 NMR 57	51% RR 0.49 (0.16–1.50)	-	61% RR 0.39 (0.21–0.69)	41% RR 0.59 (0.32–1.09)	-	-	Daga [107] 1992
Before-and-after comparison of referral patterns and PMR before and after a 3-month hospital-based training program for TBAs.	Rural Guatemala	< 20%	PMR of referred infants 200	-	-	27% ^b (81)	-	-	-	O'Rourke [56] 1995
Before-and-after comparison of the outcome of pregnancy for 1 year before and 3 years after introduction of primary health care including trained TBAs in 41 villages, and in control villages without a Primary Health Center (PHC).	Rural Gambia	< 7%	NMR 60	Apparent increase (better surveillance)	15% (64)	Apparent rise in stillbirths meant only 8% reduction in PMR	33% ^c (101)	26% ^d (24)	-	Greenwood et al. [57] 1990
Quasi-experimental study of TBA training especially in recognition of complications and referral.	Brazil rural NE	< 40%	NMR 26	-	-	-	40% ^e (23)	-	-	Janowitz et al. [58] 1988
Establishment of “mini- maternities” with telephones for TBA births. Non-randomized comparison of trained TBAs with high case load (>29 births per year) versus unattended home births.	Meta-analysis of 60 studies/ 90 datasets ranging 1971–1999 from 24 countries, Asia, Africa and Latin America-Caribbean; For IPR-NMR 3 datasets	Range	Range	-	-	Combined peri-neonatal 6% (4%–9%)	IPR-NMR 11% (2%–21%)	-	-	Sibley et al. [50] 2004
Cluster randomized, controlled trial of TBA training in antepartum, intrapartum, postpartum, and neonatal care; distribution of clean delivery kits; referral for emergency obstetrical care. Lady health workers also trained to support TBA and link community-health center services. Trained TBAs attended 74% of births in intervention group.	Rural Pakistan, Larkana, Sindh province	10%	PMR 120 ^f SBR 71 NMR 53 MMR 268	31% (483) aOR 0.69 (0.57–0.83)	-	30% ^f (823) aOR 0.70 (0.59–0.82)	29% (340) aOR 0.71 (0.62–0.83)	26% (27) aOR 0.74 (0.45–1.23)	-	Jokhio et al. [61] 2005
Before-and-after study of training of community birth attendants (TBAs, nurses) in WHO Essential Newborn Care [108], including basic resuscitation with bag-and-mask in 6 countries.	Argentina, DR Congo, Guatemala, India, Pakistan, Zambia	TBAs attend average 37% of births	PMR 46 ENMR 23 SBR 23	31% (557) RR 0.69 (0.54–0.88)	NS RR 0.99 (0.81–1.22)	15% (1367) RR 0.85 (0.70–1.02)	-	-	-	Carlo et al. [71] 2009

Abbreviations: SBR, Stillbirth Rate; ENMR, Early Neonatal Mortality rate; PMR, Perinatal Mortality Rate; NMR, Neonatal Mortality Rate; IPR-NMR, Intrapartum-related Neonatal Mortality Rate.

^a Non significant reduction in PMR among babies with “asphyxia” due to small numbers. Also note the prevalence of asphyxia was lower (0.9%) in the advanced resuscitation group, compared to the basic group (2.4%).

^b Before-after comparison.

^c Significant reduction but mainly late neonatal so probably more related to reduction in infections.

^d 61% reduction between before-and-after. Control villages fell by 35% so comparative fall of 26%, but not significant.

^e Non-significant reduction comparing TBAs with highest case load (>29 births /year) with unattended home births.

^f PMR defined as stillbirth and neonatal death up to 28 days.

[59,60]. There was a non-significant 19% reduction in PMR, and 20% lower case fatality among non-breathing babies for births attended by TBAs trained in advanced neonatal resuscitation. The “asphyxia” mortality rate was significantly reduced; however, some of the effect may also reflect the reduction in the mortality of preterm non-breathing infants.

In a recent multicenter trial, TBAs were trained in 6 countries in essential newborn care including basic neonatal resuscitation with a bag-and-mask device [71]. In a before-and-after comparison including over 57 000 births, there was a 22% reduction in PMR among those delivered by trained TBAs (RR 0.78; 95% CI, 0.63–0.96) and a 31% reduction in SBR (RR 0.69; 95% CI, 0.54–0.88), likely due to a shift in classification of babies from stillbirth to early neonatal death.

3.2.2.3. TBA training programs: Intrapartum-related mortality effect. In 2004, Sibley et al. [50] conducted a meta-analysis of 17 studies with 18 datasets ($n = 15\,286$ in treatment vs $n = 12\,786$ in control), and reported a 6% reduction in deaths in the perinatal and neonatal period in the areas served by trained TBAs (Table 6). “Birth asphyxia” mortality (3 studies, 6217 neonates in the treatment group vs 5170 controls) was significantly reduced by 11%. In the 3 studies included in the analysis of “asphyxia” mortality, TBAs conducted neonatal resuscitation—Gadichiroli, India (initial TBA training period [82]; Chandigarh, India [60] and Ethiopia [65]). However, in the recent Cochrane review [70], these studies were excluded and only 2 studies reporting PMR met methodological quality inclusion criteria (Pakistan [61] and Guatemala [56]), and were not pooled because of differences in study design. After reviewing the data, we did not identify new evidence that had comparable study design, intervention, and outcome measures for which to conduct a meta-analysis. The First Breath trial has not yet reported cause-specific mortality [71], and the before-and-after study design was not pooled with studies of quasi-experimental or cRCT design. There are 3 recently completed RCTs of TBA training that will soon help better inform this evidence base [5].

3.2.3. Cost of TBA training

The cost of TBA training per TBA may range from US \$44 in Uganda [72], US \$60 in Nepal [49], to US \$45–\$95 in Ghana, Mexico, and Bangladesh [73]. The estimated cost per TBA assisting 30 births per year would be US \$110, assuming training/supervision at US \$50 per year and supplies at US \$2 per birth [74]; training costs may be reduced after the first year but costs for supervision would remain. The cost per neonatal life saved by primary prevention of intrapartum-related hypoxia because of better management in labor by TBAs can be estimated based on an assumed reduction of 11% in IPR-NMR from a baseline rate of 10 IPR-neonatal deaths per 1000 live births [2,50]. A TBA assisting 30 births a year would then save about 1 neonate for every 1000 births or 1 neonate every 33 years, at a cost of US \$3630 per life saved, is greater than the range considered as cost-effective in low-resource settings based on 3 times gross national income per capita (per DALY averted) [2,75]. In addition, it should be noted that many TBAs perform fewer than 30 births per year, further reducing cost-effectiveness. More systematic assessment of outcomes and cost is required.

3.2.4. Implications

While the role of TBAs remains controversial, there is emerging evidence that TBA training may have positive direct effects on neonatal outcomes through primary and secondary prevention of intrapartum-related events, provided that the volume of births is sufficient to maintain skills. A previous meta-analysis demonstrated an 11% reduction in intrapartum-related mortality [50], and in a recent cRCT, TBA training resulted in 30% reduction in PMR. However, the GRADE level of evidence is low, since there is only one cRCT which reported intrapartum-specific outcomes and one meta-analysis, primarily of lower quality program experience (Table 4). More data are required before making recommendations to initiate training of TBAs for these

purposes. Future studies should include at least the following information on participants, the intervention, and outcomes, to permit analyses to inform policy and programs: (1) TBA age, socioeconomic status, educational attainment, experience, number and proportion of births attended; (2) maternal age, parity, socioeconomic status, and educational attainment; (3) training method, content, duration, contact hours, trainer/trainee ratio, supportive supervision and education after training, context, for example whether training is a single invention or part of a complex intervention, and whether it is situated within an enabling environment that includes elements such as advocacy, community mobilization, emergency transportation or adequate accessible referral sites; (4) timing of measurement relative to the intervention, data collection method and sources; (5) definition of intrapartum-related neonatal deaths and stillbirths, and inclusion of preterm deaths; and (6) cost-effectiveness [70].

The decision-making process regarding TBA training will also vary by setting. In rural settings where there are no SBAs and little hope of sustaining sufficient numbers of skilled attendants, and where access to emergency care facilities is lacking, TBA training may be considered. While TBAs cannot substitute for SBAs, they may play valuable roles in partnering with SBAs, and in providing information and support to the woman and her family. Moreover, in many settings, poor women still chose to deliver with TBAs even when skilled attendance is a possibility, illustrating that TBAs may bring value to families, particularly social and cultural skills from which SBAs could learn.

3.3. Using CHWs to promote birth preparedness and care-seeking, with or without provision of newborn care at birth

3.3.1. Background

CHWs are defined by WHO as “members of the communities where they work, selected by the communities, answerable to the communities for their activities, supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers [76]” (Table 1). CHWs may play a critical role in healthcare delivery in rural, under-resourced regions and have proven to be effective in promoting childhood immunization and the management of acute respiratory infections and malaria [77–79]. The provision of newborn care by CHWs is less controversial than the role of TBAs [13,80–83], as the selection process and the objectives, as well as the evidence for effect, are different. CHWs differ from TBAs in that they tend to be younger, more educated, and less closely bound to traditional care practices. Characteristics and training of CHWs may vary by region and even within countries, however, depending on local policy. For example in South Asia, CHWs tend to be women from the village who are trained in aspects of maternal, newborn and child health; the extensive network of CHWs in Nepal is made up largely of women volunteers [81]. In contrast, in some studies and programs in South Asia [84], and in several African countries, CHWs are male, compounding the challenge of accessing mothers and newborns during the traditional postpartum period of seclusion widely practiced in many low-resource settings [85]. In China, which promoted broad coverage with male “barefoot doctors,” particularly during the 1970s, 2–3 years of training was the norm and there was good back-up by a referral system [38].

3.3.2. Evidence for CHW packages

The evidence for CHWs in averting intrapartum-related hypoxic injury falls into 3 main categories: (1) education to increase birth preparedness and care-seeking during childbirth; (2) community mobilization activities to increase access to skilled childbirth care (detailed in the fourth paper in this series) [6]; (3) and the provision of care at delivery to recognize and manage the non-breathing baby.

3.3.2.1. CHWs for primary prevention: Improving birth preparedness and care seeking. CHWs may play an instrumental role in the primary prevention of intrapartum-related injury by educating women and

families about birth preparedness and mobilizing communities to seek skilled care during childbirth (Table 7). There are limited data on the mortality effect of birth-preparedness programs. Community mobilization is discussed in detail in the fourth paper in this series [5].

In Sylhet and 10 additional districts in Bangladesh, CHWs were trained in interventions targeting birth preparedness and essential newborn care [80,86]. After the intervention, mothers' knowledge of danger signs in pregnancy, labor and delivery, and the postnatal period significantly increased. Immediate newborn care practices, including immediately drying, warming, and stimulating the infant also improved. Furthermore, in Mirzapur district, there were some improvements in care seeking for newborn illness after CHW training, via both self-referrals and increased compliance with CHW referral [81,87,88].

In Kebemer, Senegal, CHW training was associated with significant increases in women who identified their place of delivery with a qualified provider and who had identified emergency funds or transport [89]. Pregnant women were 3-times more likely to recognize at least 4 danger signs during labor and delivery. Furthermore, the facility birth rate significantly increased from 53% to 75%, and CHWs were more likely to attend home births.

3.3.2.2. Comprehensive CHW packages targeting primary prevention: Intrapartum-related mortality effect. Several trials involving CHW training to promote birth preparedness and care seeking during pregnancy reported mortality effects; however, delivery attendance or the provision of neonatal resuscitation by CHWs did not feature prominently in most intervention packages, except for the SEARCH trial [90] (Table 8).

In Pakistan, the LHW program was established by the Ministry of Health in the early 1990s to provide primary maternal and child health services to rural and poor urban regions. In the Hala and Matiari subdistricts of rural Sindh province [83], LHWs were trained in home-based essential newborn care, provision of prenatal and postnatal care, leading group education meetings and village health committees, and working with TBAs to follow pregnancies in the community. LHWs attended few births: 5% of births in the intervention villages versus 1% in the control arm. Intervention clusters, however, had improved rates of prenatal care, skilled birth attendance at public sector facilities, reductions in home births, and significantly reduced SBR (65.9 to 43.1 per 1000) and NMR (57.3 to 41.3 per 1000). Although cause-specific mortality data are not yet available, the substantial reductions in early neonatal mortality and stillbirths may reflect the effect of these interventions on intrapartum-related deaths.

In a cRCT in Shivgarh, India, CHWs held collective meetings with community stakeholders in newborn care, and additionally made two prenatal and two postnatal home visits, covering birth preparedness, hygienic delivery, umbilical/skin care, thermal care, breastfeeding, and care seeking from trained providers [13]. The interventions were focused primarily on hypothermia and neonatal infection; however, primary prevention of intrapartum complications was addressed via improving birth preparedness, hygiene, and care-seeking activities. Pregnant mothers from CHW clusters had significant improvements in prenatal care attendance; birth preparedness indicators such as identification of a health facility and birth attendant, and arrangement of money in case of emergency prior to delivery; and care seeking during pregnancy. Furthermore, newborns in the intervention arms were more likely to be wiped-stimulated, wrapped, and receive skin-to-skin contact. PMR was significantly reduced in the essential newborn care group (aRR 0.54; 95% CI, 0.38–0.76). While IPR-NMR was not reported, the reductions in SBR (aRR 0.72; 95% CI, 0.51–1.01; essential newborn care vs control) and in ENMR (62 per 1000 live births in the control group vs 35 per 1000 in the essential newborn care group) suggest that primary prevention was effective in reducing adverse intrapartum events.

3.3.2.3. Comprehensive CHW packages including secondary prevention: Intrapartum-related mortality effect. In the SEARCH study [82] in

Gadchiroli, India, CHWs partnered with TBAs to provide childbirth care and manage the non-breathing baby in the home. This study is discussed in detail in the third paper [5]. In brief, CHWs were trained to use a tube-and-mask (1996–1999) and bag-and-mask device (1999–2003) for neonatal resuscitation and attended 78%–84% of births over the study periods. The “asphyxia” specific mortality was significantly reduced by 65%, and case fatality of “severe asphyxia” was reduced by 48% from before to after the intervention [90]. In a comparison of the intervention versus control areas during the CHW period of tube-and-mask resuscitation, “asphyxia” specific mortality was reduced by 42%. The SBR in the intervention area was lower by 49% (95% CI, 31–66), and the ENMR lower by 64% (95% CI, 49–79) versus the control area [91].

3.3.2.4. Integrated CHW packages: Meta-analysis of effect on intrapartum-related mortality. In a meta-analysis that included all the available higher-quality evaluations of primary and secondary prevention of intrapartum-related outcomes through CHWs (2 cRCTs [13,80] and 2 quasi-experimental trials [80,83]), the pooled effect on PMR was RR 0.72 (95% CI, 0.62–0.84) (Fig. 3A) and on ENMR was RR 0.64 (95% CI, 0.56–0.73) (Fig. 3B). There was only one trial that reported intrapartum-related mortality. We did not include the study by Jokhio et al. [61] because its focus was on TBA linkages with the health system, rather than program implementation through CHWs. The studies by Pratinidhi et al. [92] and Sundararaman et al. [93] were excluded because of the lower-quality, before-and-after, or historical control study designs. For the SEARCH study, the standard error was adjusted by the highest design effect of the RCTs to account for the difference in study design and small number of study clusters (2 clusters). For the Hala trial [83], we did not apply a correction and used the cluster adjusted data.

3.3.3. Cost of CHW training

The limited data on cost-effectiveness indicate that CHW programs may help improve equity in coverage for programs for the poor [91,92,94,95]. Non-recurring costs of home-based care in Gadchiroli, India came to US \$0.89 and recurring costs of care were US \$6.06 per neonate, giving a total of approximately US \$7 [91]. The estimated cost per death averted was US \$150.5 for home-based care, and in a subsequent analysis, US \$13 for equipment (bag-and-mask resuscitator) per death averted (US \$6.50 for tube mask) [91], although cost-effectiveness for the management of intrapartum-related hypoxia alone will differ from this estimate. Additional data using state-of-the art methods for determining cost-effectiveness are needed.

3.3.4. Implications

There is growing and substantial high-quality evidence that CHWs, working within the community and often with TBAs, may effectively provide packages of newborn care and significantly improve neonatal and perinatal outcomes. However, there are limited data on cause-specific mortality, therefore the GRADE level of evidence is moderate (Table 4). CHW packages may result in 36% reduction in ENMR, a substantial fraction owing to intrapartum-related neonatal deaths. Bang et al. [82] achieved high rates of birth attendance in Gadchiroli and observed a 42% reduction in intrapartum-related mortality in the area where CHWs were trained in tube-and-mask resuscitation of the non-breathing baby versus the control area. While intrapartum-related mortality data are not yet available for many other community-based RCTs, the reductions in perinatal mortality, early neonatal and stillbirth suggest that deaths due to intrapartum-related events may have been reduced in these studies as well [13,83]. However, any reduction in intrapartum-related deaths was probably mediated through primary prevention and increased care seeking for complicated births, given the low rates of birth attendance by CHWs and absence of training in neonatal resuscitation with positive pressure ventilation.

Table 7
Evidence for community health worker (CHW) packages: Intermediate outcomes 2005–2008.

Intervention/study	Setting	% skilled attendance	Baseline mortality rates	Changes in knowledge/attitudes	Changes in Care-seeking/Demand	Other Intermediate Outcomes	Investigator and year
Training of CHWs in essential newborn care, communication/education program through CHWs and mass media, and strengthening of health facilities with staff training and equipment upgrades. Before and after comparisons.	Kebemer district, Senegal Pop 67 000	~50%	NMR 31	<ul style="list-style-type: none"> • Significant increases in knowledge of birth preparedness (identify place of delivery 22% to 34%, identify source of emergency funding 23% to 76%, identify transport 8% to 30%) • Significant increases in knowledge of hypothermia management (skin to skin 22 % to 63%, wiping dry 19% to 48%), clean cord care (clean blade 26% to 55%, no topical application 43% to 90%) • Significant increases in recognition of at least 4 danger signs (18% to 54%) 	<ul style="list-style-type: none"> • Increase in facility based births (53% to 75%) • Increase in proportion of home births attended by matrons (CHWs) from 29% to 39% 	<ul style="list-style-type: none"> • Significant increase in birth-preparedness practices: pre-identifying place of delivery (57% vs 68%); choice of delivery location with qualified person (34% vs 39%) emergency fund (44% vs 78%), emergency transport (10% vs 30%) • Improvement in essential newborn care practices: skin to skin contact (2% vs 14%), drying (54% vs 73%), delayed first bath at least 6 hrs (20% vs 53%), breastfeeding in first hour (60% vs 78%) 	Ndoye et al. [89] 2004
Longitudinal before-and-after comparison of package of newborn home-based care (extension of original observation period from above study). Baseline period (1993-1995): trained TBA using mouth to mouth resuscitation. Intervention: team of TBA and semi-skilled CHW; training of CHW in tube-and-mask (1996-1999) and later bag-and-mask (1999-2003) ventilation.	Rural India Maharashtra state Intervention area: 39 312 Control area: 42 520	<5%	SBR 32 ENMR 37.5 PMR 68.3	<ul style="list-style-type: none"> • In last year of intervention (1997-8) in cross sectional survey of 726 mothers: 79% of mothers were prepared for delivery, 77% recognized signs for which VHW should be called, 85% knew delivery room should be clean, 68% could identify neonates at high risk 	<ul style="list-style-type: none"> • VHWs attend 78% of home births in 1995-1996 to 84% in 1996-2003 	<ul style="list-style-type: none"> • Incidence of "Mild asphyxia" (not breathing at 1 minute) 14.2% in 1995-1996 to 5.7% in 2000-1003 • Incidence of "Severe asphyxia" (not breathing at 5minutes) 4.6% in 1995-1996 to 4.9% in 2000-2003 • Delayed breastfeeding decreased from 9.3% to 1% 	Bang et al. [90] 2005
CHWs trained in essential newborn care conducted door-to-door visits to identify and follow women during pregnancy and post-natal period, educate mothers about newborn care and danger signs. Before and after comparisons.	Rural Bangladesh, 10 upazilas (subdistricts)		NMR 41	<ul style="list-style-type: none"> • Mothers' knowledge of at least 2 danger signs during pregnancy increased from 31.1% to 77.6% • Maternal knowledge of at least 2 danger signs during labor and delivery increased from 77.8 to 91.1% • Maternal knowledge of at least 2 postnatal danger signs increased from 47.1% to 64.3% 	<ul style="list-style-type: none"> • Postnatal check up of infant within 24 hrs by trained provider increased from 14% to 27% • Postnatal check up of mother within 24 hrs by trained provider increased from 2% to 27% 	<ul style="list-style-type: none"> • Increase in newborn drying and wrapping after birth (14% to 55%) • Increase in breastfeeding within 1 hour of birth (39% to 76%) • Delayed bathing by 24 hours increased (22% to 82%) 	Syed et al. [86] 2006
Promotion of family care-seeking for maternal-newborn care through behavior change communication, identification and referral of sick infants by CHWs and strengthening of neonatal care in health facilities. Mid-study CHWs received emphasized training on management of birth asphyxia and antepartum family counseling on asphyxia.	Mirzapur upazila, Rural central Bangladesh				<ul style="list-style-type: none"> • Increased family compliance with CHW referral to hospital over study period (56% baseline vs 80% end line) • Significant increase in proportion of sick newborns seeking care from qualified providers in intervention area (31% vs 60% end line, OR 2.98; 95% CI, 2.00–4.44) • Significant increase in care seeking from Kumudini Hospital 18% vs 46%, OR 2.90; 95% CI, 1.91–4.41) • Significant 		Bari et al. [109] 2006

<p>Promotion of Birth-Preparedness Package (BPP) by community mobilizers (CHWs, trained TBAs) who conducted inter-personal counseling and mother's groups with flipcharts covering topics including: antenatal care, care for mother and newborn during/after delivery, danger signs, and financial/transport planning. Before and after comparison.</p>	<p>Rural Siraha, eastern Nepal Pop: 615 000</p>	<p>17% at baseline 18% at end line</p>	<p>IMR 81</p>	<ul style="list-style-type: none"> • Increase in antenatal (84% vs 60% with 1+ ANC visit) and post natal care (25% vs 11% within 1 wk of delivery) • No change in use of skilled birth attendant (18% vs 17%) • No change in care seeking during emergency (85% vs 83%) 	<ul style="list-style-type: none"> • Significant increase in birth-preparedness index (54 vs 33) • Improvements in essential newborn care practices by 20-30% compared to baseline (use of clean delivery kit, breastfed within 1 hr, delayed bathing, nothing applied to cord, wrapped immediately) 	<p>McPherson et al. [110] 2006</p>
<p>Pilot study training of Lady health workers (LHW, CHW) and Dais (TBAs) in home based newborn care (including basic resuscitation)^c, improvement of linkages between LHWs and Dais, and community mobilization with group educational sessions and establishment of health committees and emergency transport funds. Strengthening of health facilities in intervention/control areas with training and upgrading equipment.</p>	<p>Hala and Matiari subdistricts, rural Sindh province, Pakistan Intervention: 2672 Control: 2462</p>	<p>Baseline skilled attendance 18% (30% endline in intervention areas) LHWs attended 12% of births in intervention areas (1.4% in control)</p>	<p>NMR 57.3</p>	<ul style="list-style-type: none"> • Proportion of births with skilled attendant in public sector facility increased from 18 to 30% in intervention clusters • Antenatal care during pregnancy 79% in intervention villages vs 66% in control • Presence of LHW during delivery 12% in intervention areas vs 1.4% control 	<ul style="list-style-type: none"> • Improvements in immediate breastfeeding (66% vs 21% in control), delayed bathing at least 4 hours after birth (50% vs 30% control), colostrums administration (76% vs 40%) • Newborn exam within 48 hours (56% vs 39%) 	<p>Bhutta et al. [83] 2008</p>
<p>Cluster randomized controlled trial (cRCT) of package of birth and newborn care preparedness (BNCP) interventions in Home vs Community care. In Home-care group CHWs provided antenatal visit, promoted BNCP, postnatal visits in first week of live, referred sick newborns, and treated sepsis at home with injectable antibiotics. In Community care arm, community mobilizers promoted BNCP in group sessions. In comparison and intervention arms improvement of government health facilities.</p>	<p>Rural Sylhet district, Bangladesh Home care: 14 880 Community care: 16 449 Comparison: 15 779</p>	<p>CHWs attended 5% of births</p>	<p>in study area NMR 48</p>	<ul style="list-style-type: none"> • Higher proportion with an antenatal visit in Home care vs comparison arms at endline (72% vs 49%) 	<ul style="list-style-type: none"> • Higher proportion taking iron-folate supplementation in home care vs comparison (84% vs 25%) • Delayed first bath at least until day 3 (78% vs 25%) • Breastfeeding within 1 hr (81% vs 57%) • Clean cutting of the umbilical cord (95% vs 61%) 	<p>Baqui et al. [80] 2008</p>
<p>cRCT of essential newborn care package delivered by CHWs via collective meetings, antenatal and postnatal visits. Extensive participatory social mapping and formative research conducted in local community to develop behavior change strategies for intervention package. Intervention clusters received either essential newborn care (ENC) package or ENC plus use of a hypothermia indicator.</p>	<p>Shivgarh, Rural Uttar Pradesh province India Total population of study area: 104 123</p>	<p>Baseline skilled attendance in all groups <5%</p>	<p>stillbirth 24.4 (ENC) 27.2 (control) NMR 64.1 (ENC) 54.2 (control)</p>	<ul style="list-style-type: none"> • Increased Routine antenatal care checkup in ENC vs comparison (RR 1.84; 95% CI, 1.08–3.14) • Maternal Care seeking from nurse midwife in ENC vs comparison (RR 1.42; 95% CI, 1.09–1.85) • Delivery in Health Facility ENC vs comparison (RR 1.41; 95% CI, 0.93–2.13) 	<p>Improved birth preparedness in ENC vs comparison</p> <ul style="list-style-type: none"> • Identification of health facility (RR 3.43; 95% CI 2.12-5.54) • Identification of delivery supervisor (RR 5.79; 95% CI 4.16-8.06) • Identification of newborn attendant (RR 4.94; 95% CI 3.19-7.63) • Previous arrangement of money (RR 1.55; 95% CI 1.15-2.09) • Wiping of body right after delivery (RR 5.05, 95% CI 4.20-6.06) 	<p>Kumar et al. [13] 2008</p>

Table 8
Evidence for impact of community health worker (CHW) packages: Mortality effect.

Intervention/study	Setting	Percentage skilled attendance	Baseline mortality rates	Mortality Effect: % Relative Reduction in Mortality Rate (number of deaths in intervention or end-line group); RR or OR (95% CI)						Investigator and year
				SBR	ENMR	PMR	NMR	IPR-NMR	MMR	
Before-after study where CHWs made 3 post-natal home visits over the first month of life, performed essential care and screened for risk factors/referral; attended some births. Quasi-experimental controlled field trial of a package of newborn home-based care mainly implemented through trained and supervised CHWs. The package included health education of pregnant women and the community, attending delivery, neonatal resuscitation, essential newborn care and management of neonatal infections. Mortality as well as morbidity outcomes were recorded.	Rural India near Pune	25%	NMR 52	-	-	-	25% (60) RR 0.74 (0.52–1.04)	-	Pratinidhi et al. [92] 1986	
	Rural India Maharashtra state Intervention area: 39 312 Control area: 42 520	< 5%	SBR 32 ENMR 37.5 PMR 68.3	49% ^a (26) RR 0.51 (0.34–0.69)	64% ^a (22) RR 0.36 (0.21–0.51)	50% ^a (48) RR 0.50 (0.35–0.71)	62% ^a (25) RR 0.48 (0.31–0.75)	48% ^b (5)	-	Bang et al. [82] [66] 1999
Longitudinal before-and-after comparison of package of newborn home-based care (extension of original observation period from above study). Baseline period (1993–1995): trained TBA using mouth-to-mouth resuscitation. Intervention: team of TBA and semi-skilled CHW; training of CHW in tube-and-mask (1996–1999) and later bag-and-mask (1999–2003) ventilation.	Rural India Maharashtra state 39 villages: total population 38 998; 4033 home births during study period	89–95% Home births, 92–97% conducted by TBAs; 77–84% attended by CHWs	NMR 52/1000 ASMR 10.5/1000 Incidence: "Mild birth asphyxia" 14.2% "Severe birth asphyxia" 4.6%	32.6% reduction in fresh stillbirth rate ^c			65% ^d reduction in IPR-NMR (20) 42% reduction in IPR-NMR with tube and mask (37) ^e		Bang et al. [90] 2005	
Historical study of broad range of government sponsored activities to improve rural child health, including training of 54,000 community volunteers (Mitansins) to provide child survival interventions and essential newborn care, community mobilization, and family outreach/counseling	Chhattisgarh, Rural India Madhya Pradesh	Not stated	IMR 95 in 2000				IMR 32% ^f	Sundaraman et al. [93] 2007		
	Rural Sylhet district, Bangladesh	CHWs attended 5% of births	Baseline in study area 48				Home Care arm 34% ^h (82) aRR 0.66 (0.47–0.93)	Baqui et al. [80] 2008		
Cluster randomized controlled trial (cRCT) of package of birth and newborn care preparedness (BNCP) interventions in Home vs Community care. In Home-care group CHWs provided antenatal visit, promoted BNCP, postnatal visits in first week of live, referred sick newborns, and treated sepsis at home with injectable antibiotics. In Community care arm, community mobilizers promoted BNCP in group sessions. In comparison and intervention arms improvement of government health facilities.	Home care: 14 880 Community care: 16 449 Comparison: 15 779									
Quasi-experimental study training of Lady health workers (LHW, CHW) and Dais (TBAs) in home based newborn care (including basic resuscitation) ^e , improvement of linkages between LHWs and Dais, and community mobilization with group educational sessions and establishment of health committees and emergency transport funds. Strengthening of health facilities in intervention/control areas with training and upgrading equipment.	Hala and Matiari subdistricts, rural Sindh province, Pakistan Intervention pop: 74 083 Control pop: 64 517	Baseline skilled attendance 18% (30% endline in intervention areas) LHWs attended 12% of births in intervention areas (1.4% in control) Baseline home births 79% (65% endline in intervention areas)	Baseline stillbirth 65.9 (intervention) Baseline NMR 57.3 (intervention)	35% ⁱ (132)	36.2% ⁱ (90)	34.6% ⁱ (222)	28% ⁱ (121)	Bhutta et al. [83] 2008		
cRCT of essential newborn care package delivered by CHWs via collective meetings, antenatal and postnatal visits. Extensive participatory social mapping and formative research conducted in local community to develop behavior change strategies for intervention package. Intervention clusters received either essential newborn care (ENC) package or ENC plus use of a hypothermia indicator (TS).	Shivgarh, Rural Uttar Pradesh province India Total population of study area: 104 123	Baseline skilled attendance in all groups <5%	Baseline stillbirth 24.4 (ENC) 27.2 (control) Baseline NMR 64.1 (ENC) 54.2 (control)	ENC: 28% (59) RR 0.72 (0.52–0.90) ENC + TS: 15% (48) RR 0.85 (0.56–1.29)	ENC: 44% (51) ENC + TS: 47% (36)	ENC: 41% (113) aRR 0.59 (0.47–0.74) ENC + TS: 38% (96) aRR 0.62 (0.47–0.81)	ENC: 54% (64) aRR 0.46 (0.35–0.60) ENC + TS: 52% (48) aRR 0.48 (0.35–0.66)	Kumar et al. [13] 2008		

Abbreviations: SBR, Stillbirth Rate; ENMR, Early Neonatal Mortality rate; PMR, Perinatal Mortality Rate; NMR, Neonatal Mortality Rate; IPR-NMR, Intrapartum-related Neonatal Mortality Rate. ^a Comparison of rate in intervention vs comparison areas in last year of study 1997–1998. ^b Change in cause-specific NMR in intervention area from 1995–6 to 1997–8. ^c Data on "fresh" stillbirth only available after 1996 in intervention regions. Comparison in rate from 1996–1999 to 1999–2003. ^d Change in cause-specific NMR in intervention area from 1995–6 to 1997–2003. ^e Comparison of IPR-NMR in intervention vs comparison areas 1996–1999. ^f Comparison of IPR-NMR in intervention vs comparison areas 1993–1995. ^g Historical data and should be interpreted with caution as many other factors may have influenced the reduction. ^h NMR reduction in neonates receiving Home care was likely due to reduction in infection related deaths, given low birth attendance of CHWs (5%). ⁱ Before-after comparison in intervention arm.

While our recommendation for use of CHWs in programs to reduce intrapartum stillbirths and IPR-NMR is strong (Table 4), there is a need to further assess the effect and cost-effectiveness of community-based CHW packages on intrapartum-specific mortality and examine the mechanisms (e.g. better management in labor or better resuscitation) more closely under a variety of conditions. Furthermore, as with the other community-based providers, the linkages to the formal health system are paramount for the ultimate success of these programs.

4. Discussion

While striving to achieve universal skilled childbirth attendance, it may be years before this can be realized, particularly in rural, remote, and resource-limited settings. As part of health systems strengthening, the utilization and mobilization of community-based providers, including trained TBAs and CHWs, but preferably community-based SBAs, is a potential strategy to increase access to essential pregnancy and childbirth care for the poor, link pregnant women to the formal health system, and improve perinatal outcomes [3,9]. There is growing program experience and observational data that training SBAs in the community may reduce IPR-NMR by around 20%. The evidence is strong that CHWs help mobilize communities to seek care and provide essential newborn care—our new meta-analysis suggests approximately 30% reduction of PMR (Fig. 3A). There is lower quality evidence for neonatal resuscitation by CHWs [5]. While the role of TBAs is controversial, there is some evidence from a previous meta-analysis that trained TBAs may reduce IPR-NMR by 11% [63]. Additional evidence from a recent cRCT reports that when TBAs are linked with the formal health system, use of EmOC may be increased and associated with a similar PMR reduction (30%) [61].

In high mortality regions with low skilled birth attendance rates, increasing coverage of both community and facility-based care to 90% could avert up to 67% of all neonatal deaths [96]. Phased scale up of evidence-based community outreach services in parallel with continued health system strengthening may also reduce inequities in access for the rural poor [3,97]. Community and outreach care have been estimated to reduce neonatal deaths by around a third, and are feasible even in settings with weaker health systems [96]. Impact at community level may be further increased through adaptation and introduction of selected tools and technologies, including some that are currently in use in referral-level facilities (Fig. 3).

The primary prevention of intrapartum-related hypoxia by community cadres requires the rapid recognition of obstetric complications, functioning referral and transport systems, and timely access to CEmOC, including cesarean delivery in cases of severe complications. Studies of all three community cadres (i.e. community-based midwives, TBAs, CHWs) have demonstrated that with adequate training, danger signs can be identified during pregnancy and labor, and referral facilitated [10,19,22–29,33,36,40,52]. There is convincing evidence from cRCTs demonstrating that CHW interventions may mobilize communities to increase rates of care seeking and skilled birth attendance [83,98], and that properly trained and supervised TBAs can successfully identify and refer cases for CEmOC [61]. However, ongoing supervision remains a challenge, and cost-effectiveness data are needed. SBAs may monitor the progress of labor and reduce delays to CEmOC by directly providing potentially life-saving emergency obstetric interventions in the home or in birthing centers [29,40]; the private sector can potentially play an important role in the establishment of birthing centers (e.g. nursing homes in India) within the community. An unresolved issue is what proportion of community-based SBAs actually perform advanced interventions such as vacuum extraction, and what the competency, safety, and effect of conducting these procedures are in the home setting. This is a critical programmatic issue that requires improved monitoring, evaluation, safety, and cost-effectiveness evaluation, particularly as several national programs (Indonesia, Bangladesh) have been instituted

to scale up SBAs in communities [10,20]. Finally, in cases of severely obstructed labor, operative delivery may be the only intervention to prevent intrapartum-related hypoxic injury, and community-based care must be adequately linked to CEmOC to reduce this burden; further consideration should be given to task shifting to cadres closer to the community to reduce this burden [4].

Community cadres may engage in the secondary prevention of intrapartum-related deaths by the early recognition of the non-breathing baby, and intervening through drying, stimulation, and/or provision of positive pressure ventilation [5]. There is low-quality evidence that neonatal resuscitation may be performed by community midwives [33], CHWs [99], and even potentially TBAs [60], resulting in reductions in IPR-NMR [5]. In a recent Delphi expert panel, community-based neonatal resuscitation was estimated to reduce IPR-NMR by 20% [100]. However, there are many programmatic and setting-specific considerations, including the effect of this approach on long-term neuro-developmental outcomes that must be carefully weighed in regions where births commonly occur at home and resources are limited. Neonatal resuscitation and specifically programmatic issues in the implementation of this intervention in low-resource settings are discussed in detail in the third paper in this Supplement [5].

The success of maternal-child health interventions within a community requires a careful understanding of the local culture and customs surrounding childbirth and the role of key stakeholders [13]. Interventions should be developed for and tailored to the epidemiological context of the local setting and the cultural beliefs and practices surrounding the disease process, and be targeted to reduce risk factors for mortality. Traditional birth practices for the baby who is not breathing at birth may vary widely between cultures (see first paper in this Supplement). While many practices are healthy methods of physical stimulation, others may be harmful for the newborn or delay the time to a more appropriate action, such as establishing effective ventilation. Framing community-based interventions for intrapartum-related hypoxia within local beliefs and customs may increase the adoption of healthy community practices and acceptance of interventions by community-based providers and families.

Innovative tools and technology are an important potential means for increasing coverage of effective interventions. Developing and adapting tools and technologies for use in more peripheral health systems settings may help bring pregnant mothers in the community closer to facility care, such as the use of cellular phones or resourceful transport vehicles like bicycle stretchers. This approach may also bring improved childbirth care directly to the home, such as clean birth kits, home birth and immediate newborn care kits with bag-and-mask and suction devices, or Doppler ultrasound-fetal heart rate monitors. Several key current tools in use and future development needs are highlighted in Fig. 4.

There are many considerations and challenges to feasibility and scale up of community-based interventions during pregnancy and childbirth that will reduce the effect of intrapartum-events, and several are highlighted in Table 9. First, the availability and skill capacity of the existing cadre providing childbirth care in the community must be carefully considered. While the ideal cadre is the SBA or midwife, in most low- and middle-income settings there is insufficient human resource capacity to staff hospital facilities and, thus, even lower potential to retain skilled providers in remote or rural settings. In some settings, TBAs may already attend the majority of births, and incentives may be offered to engage them in the formal health system to encourage partnership with CHWs, midwives, or medical doctors and change behaviors with culturally contextualized training programs; however, evidence for the effect of such an incentivized approach is needed. Secondly, the skills and competence of community cadres need to be carefully evaluated, monitored, and supervised. Whether ranging from danger sign recognition to neonatal resuscitation or extensive measures such as administration of uterotonics or assisted delivery, training does not equate to adequate

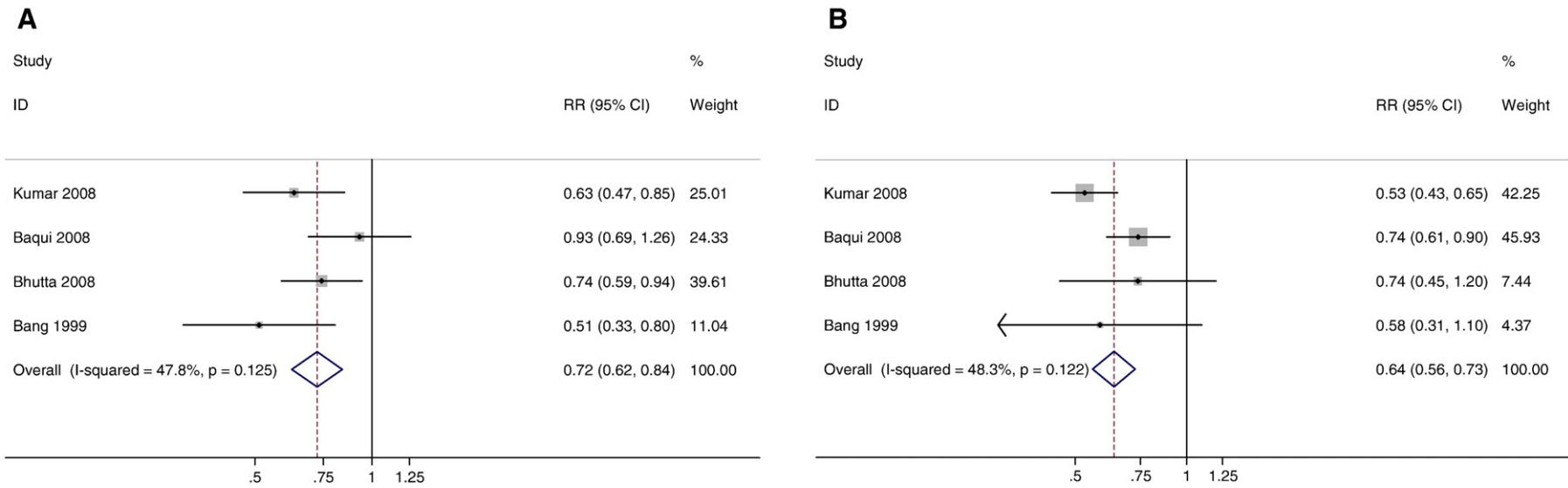


Fig. 3. Meta-analysis of mortality effect of community health worker packages. (A) Perinatal mortality. (B) Early neonatal death.

care provision, and skill competence, retention, and health outcomes must be carefully monitored and ongoing retraining and supervision ensured [19].

5. Conclusion

The majority of maternal and newborn deaths occur in regions where most births occur outside facilities and without skilled childbirth care. In systems with the resources to train SBAs, community midwives may provide elements of EmOC, which may

have the potential to avert intrapartum-related stillbirth and neonatal deaths, although the evidence is presently limited. Other community cadres may be formally linked to the healthcare system, and their roles may be adapted and/or enhanced to include community education and empowerment, identification and referral for obstetric complications, birth and newborn care preparedness, or even neonatal resuscitation. These strategies have proven to be effective in several cRCTs with CHWs and/or TBAs. Community-based approaches require a functioning continuum of care and effective linkages with CEmOC health facilities. More research is needed to determine the cost-

Current Technology/Tools	Development needs
Preparation for birth	
<p>Community mobilization materials e.g. puzzles used in Nepal</p> <p>Communication tools such as folk songs used to disseminate birth preparedness messages</p> 	<p>Generic set of community mobilization materials for local adaptation organized per visit (e.g. 2 during pregnancy and 2-3 after birth)</p> <p>Generic communications toolkit for local adaptation</p> <p>Effectiveness of picture cards for counseling and recognizing complications with mother and newborn.</p>
Identifying complications and facilitating referral	
<p>Communication technology such as 2 way radios or cell phone technologies (see Paper 4)</p> <p>Transport vehicles and mechanisms for pregnant women (stretchers, bicycle ambulances, motorcycle ambulances) (see Paper 4) [6]</p> 	<p>Refine and test information communication technology tools and approaches in various settings.</p> <p>Lower cost</p> <p>Local adaptation and production</p> <p>Effectiveness of picture partograph for recognition of complications during labor and childbirth.</p>
Home Births	
<p><i>Clean birth kit (ideally locally made and marketed)</i></p> <ul style="list-style-type: none"> • Plastic sheet • New/sterilized blade • Soap • Sterilized cord tie • Pictographic instructions with behavior change messages on hygiene and use of items in the kit 	<p>Evaluate use of clean birth kits by various cadres for effectiveness and cost</p> <p>Evaluate barriers to community demand and inform strategies to overcome them</p>
<p><i>Home birth and immediate newborn care kit (in addition to clean birth kit)</i></p> <ul style="list-style-type: none"> • Low-reading Digital thermometer • Weighing scale • Simple suction device • Bag-and-mouth device • Pictographic instructions on danger signs for referral to facility 	<p>Evaluate use of home birth and immediate newborn care kits by various cadres for effectiveness and cost</p> <p>Advance designs for low cost, robust fetal heart rate monitors, ultrasound for pelvimetry, and user-friendly blood pressure devices</p>
<p><i>Equipment for birthing center or first level facility with skilled attendants</i></p> <ul style="list-style-type: none"> • Doppler ultrasound-fetal heart rate monitor • Oxytocin for active management of third stage of labor 	<p>Test use of needle-free or simplified injection technology (eg Uniject for administering oxytocin or antibiotics)</p> <p>Test effectiveness of oral misoprostol for postpartum hemorrhage</p>

Community mobilization maternal and partograph images reprinted with permission granted by Uganda MoH/Save the Children, clean birth kit image reprinted with permission granted by Program for Appropriate Technology in Health (PATH), home birth kit image reprinted with permission granted by SEARCH, Gadchiroli, India, Doppler ultrasound-fetal heart monitor image reprinted with permission granted by Healthcheck Systems/www.healthchecksystems.com

Sources: PATH. 2001. Basic Delivery Kit Guide. Washington, DC: PATH.
PATH. Birth weight scale

Fig. 4. Community level care: Tools, technologies, and further development innovations required.

Table 9
Implementation considerations for programs.

Skilled Birth Attendants	Provider qualifications
	• Supply of potential candidates/skilled providers for training
	• Existing cadres
	• Selection and prerequisite education, medical experience
	Training
	• Duration, methodology and quality of training – lecture vs clinical
	• Soft skills – counseling, negotiation, behavior change management
	• Skill retention and need for frequent re-training
	• Frequency of births
	• Need for supervision and mentoring
Traditional Birth Attendants	Referral management
	• Referral management
	Scope of practice (Basic emergency obstetric care, BEmOC)
	• Performing of assisted births (vacuum, forceps) in community setting
	• Partograph use
	• Oxytocin administration
	• Anti hypertensive medications for pre-eclampsia
	• Manual removal of placenta
	• Neonatal resuscitation
	Retention and quality of care
Community Health Workers	• Work force retention in rural areas, eg compensation, incentives, professional development
	• Quality audits
	• Community appraisal
	Linkages with community
	• Synergy with other cadre of community-based health providers
	• Partnership and dialogue with key stake-holders for optimal utilization of community resources
	Linkages with health system
	• Access to emergency fund, referral and transport systems to EmOC
	• Capacity, timeliness and quality of emergency obstetric care
	• Clinical audit and quality assurance
Community Health Workers	Monitoring and Evaluation
	• % births attended, maternal and neonatal outcomes
	• Procedures and resuscitation conducted, competence
	• Key indicators: intrapartum stillbirths, early neonatal death, neonatal encephalopathy
	Provider qualifications
	• Education level, literacy
	• Living within community
	• Linkages with other cadres, and relationships
	• Volume of births conducted
	• Preferred care provider by community
Training	
• Modification of her current practices by incorporating useful techniques and skills and avoiding harmful practices and advocating towards shifting social norms	
• Scope of training – e.g. counseling, behavior change, detection and referral, or also additional skills	
• Sustaining acquired skills and practices, skill retention and need for re-training, motivation of behavior change	
• Need for supervision and mentoring	
Retention	
• Compensation, incentives,	
Linkages with health system	
• Access to emergency funds, referral and transport systems	
• Incentives for referral	
Monitoring and evaluation	
• % births attended, outcomes, newborns resuscitated if relevant, maternal and neonatal outcomes	
• Proportion of pregnancies attended, uptake of ANC by mothers	
• Adherence to safe birthing practices	
• Number of appropriate referrals made for labor-delivery complications	
• Key indicators: intrapartum stillbirth, early neonatal death, neonatal encephalopathy	
Provider qualifications	
• Education level, literacy	
• Living in community	
• Existing cadres, and relationship with them	
Training	
• Duration and methods of training	
• Participatory action learning cycle methods to lead community groups	
• Behavior change management skills (including communication and negotiation skills) birth preparedness and recognition of danger signs	
• Neonatal resuscitation if appropriate and likely to be present at birth	
• Competence, skill retention and need for frequent re-training, supervision-mentoring	
Retention	
• Compensation, incentives	
Linkages with health system	
• Access to emergency fund, referral and transport systems to EmOC	
• Incentives for referral	

Table 9 (continued)

Linkages with community
• Synergy with other cadre of community-based health providers
• Partnership and dialogue with key stake-holders for optimal utilization of community resources
Monitoring and evaluation
• % high risk cases screened during antenatal period
• % sought appropriate and timely care from trained providers
• % births attended; % facility births; maternal and neonatal outcomes
• Number of referrals made and followed (for labor or delivery complications)
• Number of infants resuscitated at home and transported to higher center
• Key indicators: intrapartum stillbirths, early neonatal death, neonatal encephalopathy

effectiveness, sustainability, scalability and long-term impact, including neurodevelopmental outcomes, of such approaches. While the goal is to have a skilled attendant at every birth, innovative community strategies with health systems strengthening may provide childbirth care to the poor, help reduce the gross inequities in maternal and newborn survival and stillbirth rates, and provide an effective transition to higher coverage for facility births.

6. Conflict of interest

All authors have no conflicts of interest to declare.

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