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Training traditional birth attendants to use misoprostol and an absorbent delivery mat in home births

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ABSTRACT

A 50-fold disparity in maternal mortality exists between high- and low-income countries, and in most contexts, the single most common cause of maternal death is postpartum hemorrhage (PPH). In Bangladesh, as in many other low-income countries, the majority of deliveries are conducted at home by traditional birth attendants (TBAs) or family members. In the absence of skilled birth attendants, training TBAs in the use of misoprostol and an absorbent delivery mat to measure postpartum blood loss may strengthen the ability of TBAs to manage PPH. These complementary interventions were tested in operations research among 77,337 home births in rural Bangladesh. The purpose of this study was to evaluate TBAs' knowledge acquisition, knowledge retention, and changes in attitudes and practices related to PPH management in home births after undergoing training on the use of misoprostol and the blood collection delivery mat. We conclude that the training was highly effective and that the two interventions were safely and correctly used by TBAs at home births. Data on TBA practices indicate adherence to protocol, and 18 months after the interventions were implemented, TBA knowledge retention remained high. This program strengthens the case for community-based use of misoprostol and warrants consideration of this intervention as a potential model for scale-up in settings where complete coverage of skilled birth attendants (SBAs) remains a distant goal.

Introduction

Background

A 50-fold disparity in maternal mortality exists between high- and low-income countries, and in most contexts, the single most common cause of maternal death is postpartum hemorrhage (PPH) (Anderson, 2009; Khan, Wojdyla, Say, Gulmezoglu, & Van Look, 2006). Thus, a critical part of the strategy to reduce the maternal mortality ratio (MMR) is to reduce maternal mortality attributable to PPH (Potts & Hemmerling, 2006).

In response to the fifth Millennium Development Goal, which calls for a reduction of maternal mortality by three-quarters by the year 2015, the international maternal health community has placed an emphasis on increasing access to skilled birth attendants (SBAs) (Adegoke & van den Broek, 2009). However, in most settings with a high MMR, the ratio of SBAs to women remains low and progress slow (Prata et al., 2011). In Bangladesh, where only 18% of women had deliveries accompanied by a doctor or other health professional in the 5 years prior to 2007, having a skilled provider for every delivery is still a very distant goal (National Institute of Population Research and Training, Mitra and Associates, & Macro International, 2009). One potential strategy to reduce the MMR is to strengthen the ability of active traditional birth attendants (TBAs) to manage PPH (WHO, UNFPA, & UNICEF, 1992). Although most research indicates that TBA training is unlikely to contribute to a reduction in MMR, there are very few studies documenting the impact, or even potential impact, of training TBAs to use misoprostol for PPH prevention (Mobeen et al., 2011; Prata, Gessessew, Abraha, Holston, & Potts, 2009; Walraven et al., 2005).

Over the past two decades, a consensus has emerged that TBAs should not be trained to manage deliveries. Instead, it is suggested that they be incorporated into the skilled attendant strategy as advocates for skilled care, encouraging women to obtain antenatal, obstetric, and postnatal care within the formal health care system

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(Bergstrom & Goodburn, 2001; Campbell & Graham, 2006; Goodburn, Chowdhury, Gazi, Marshall, & Graham, 2000; Sibley & Sipe, 2006). Many believe that maternal health resources should not be diverted from the goal of increasing the proportion of the population attended by SBAs (De Brouwere, Tonglet, & Van Lerberghe, 1998; World Health Organization, 2004). However, the high proportion of deliveries currently unattended by SBAs—a proportion that is unlikely to change substantially for several decades—makes a strong case for investigating task-shifting interventions that may enable women to have safer deliveries until SBAs are truly accessible (Prata et al., 2011).

According to the WHO, task shifting is the "process of delegation whereby tasks are moved, where appropriate, to less specialized health workers" (World Health Organization (WHO), 2007). Task-shifting can occur within a clinical setting or can entail a shifting of responsibilities from facility-based to community-based providers. A recent review of the literature by Byrne and Morgan (2011) indicates that the integration of TBAs through task-shifting could have a profound impact on safe motherhood efforts (Byrne & Morgan, 2011). It is important to note that TBAs' traditional knowledge and practices can be an impediment to adopting new behaviors (Saravanan, Turrell, Johnson, Fraser, & Patterson, 2011). Trainers of community-based providers need to understand and address local birthing practices, especially those that could be harmful or delay transfer (Saravanan et al., 2011). Better utilization, training, and supervision of TBAs in the use of existing technologies can improve maternal health by increasing referrals and utilization of SBAs (Byrne & Morgan, 2011). Other healthcare interventions (related to HIV/AIDs, childhood pneumonia, and malaria) have already demonstrated considerable success by incorporating task-shifting to improve access to services and mitigate the shortage of health professionals (Babigumira et al., 2009; George, Menotti, Rivera, & Marsh, 2011; Yeboah-Antwi et al., 2010).

Two existing safe motherhood technologies with the potential to be delivered by TBAs have been tested in this study. Training TBAs in the use of these technologies is intended to reduce PPH specific maternal morbidity and mortality in home deliveries conducted by TBAs or family members. The first intervention is misoprostol, a uterotonic increasingly used in obstetrics to safely and effectively control PPH (Hofmeyr et al., 2009). Misoprostol is nearly as effective as its injectable counterpart, oxytocin, but carries the additional advantages that it can be delivered orally and is thermostable, making it ideal for use where refrigeration does not exist (Prata et al., 2006). The WHO recommends oral administration of misoprostol for the prevention of PPH, but it can also be used rectally, sublingually, buccally, and vaginally (World Health Organization (WHO), 2011). Misoprostol is the only option currently available to prevent or treat PPH in the absence of health workers trained to administer oxytocin, and evidence suggests it is highly cost-effective (Bradley, Prata, Young-Lin, & Bishai, 2007; Prata, Sreenivas, Vahidnia, & Potts, 2009).

The second intervention, known as "*Quaiyum's mat*" in Bangladesh, is an absorbent delivery mat designed to hold 500 ml of blood, the standard threshold for PPH. During home deliveries, women benefit if their chosen providers have a reliable method of measuring blood loss and identifying the onset of PPH. While it is generally recommended that women delivering at home be transferred to a health facility if they lose 500 ml of blood, visual observation tends to underestimate the actual amount of blood loss unless a reliable method of measurement is used (Chalmers, Murray, & Marc, 1989). One example of an effective blood measurement tool is the traditional cloth used by TBAs in Tanzania called the "kanga," two of which absorb about 500 ml of fluid (Prata, Mbaruku, & Campbell, 2005).

The purpose of this study was to evaluate TBAs' knowledge acquisition, knowledge retention, and changes in attitudes and practices related to PPH management in home births after undergoing training on the use of misoprostol and the delivery mat.

Study context

Operations research to assess the feasibility and acceptability of scaling up community-based provision of misoprostol and the delivery mat at home births was carried out in the six northernmost rural districts of Rangpur Division, Bangladesh. A total of 118,500 women enrolled, and the experiences of the 77,337 women who delivered at home during the study period were captured to assess the impact of the misoprostol and delivery mat interventions. The pregnant women involved were the clients of a well-established, local, non-governmental organization, Rangpur Dinajpur Rural Services (RDRS) Bangladesh. The project was managed by scientists at the International Centre for Diarrheal Disease Research, Bangladesh (icddr,b) in Dhaka in collaboration with the Bixby Center for Population, Health and Sustainability at the University of California, Berkeley, and Venture Strategies Innovations.

RDRS trains and oversees about 600 traditional birth attendants who are affiliated with 203 antenatal clinics across the six study districts. These TBAs are officially under the supervision of 62 trained community health workers (CHWs). CHWs lead the clinic-based antenatal care, but they are not trained in midwifery and do not attend home births. TBAs conduct home deliveries and play a critical role in drawing clients into the clinics and reinforcing and explaining the key health promotion messages in the communities. Prior to the misoprostol and delivery mat intervention, RDRS was selling a clean delivery kit to interested families containing a sterile razor blade, thread, cotton gauze, a plastic sheet (to deliver on), and a bar of soap. At that time, TBAs identified PPH by visual estimation only and transferred all suspected cases to the nearest facility. The intervention added two items to the clean delivery kit (at no additional fee): a package of three misoprostol tablets for PPH prevention (a total of 600 μg, to be administered immediately after delivery of the baby and confirmation that there was no twin) and one delivery mat (to measure blood loss), which was developed and tested by Dr. MA Quaiyum and colleagues at icddr,b (Quaiyum, Hossain, & Steatfield, 2006).

Methods

The TBA evaluation study was nested within the misoprostol and delivery mat intervention, and conducted from July 2009 to January 2011. A total of 696 field staff, 588 of which were RDRS TBAs, received two days of training on misoprostol and delivery mat usage between April 1st and May 16th, 2009. Participating TBAs were all existing RDRS TBAs who worked and lived in the intervention areas. Prior knowledge and attitudes of TBAs were assessed in advance of the training to better understand their perspectives. The training was provided by a team of four physicians from icddr,b and RDRS, who had experience working with TBAs and had previously conducted TBA trainings. icddr,b and Bixby Center researchers prepared the training protocol, which incorporated classroom time and a practicum, including practice on a pelvic model and role play.

Training covered information on various aspects of misoprostol (function, dosage, timing of administration, side effects and their management, etc.) and the use of the delivery mat. The training also provided information on identifying high-risk pregnancies, danger signs in pregnancy, referral procedures, stages of labor, newborn resuscitation, maternal infection, and general use of clean delivery kits with the two new components. Trainers gave particular attention to PPH and other complications that require referral. Monitoring of TBAs continued until January 2011. Ethical approval for the TBA evaluation study was provided by the Committee for

the Protection of Human Subjects at the University of California, Berkeley (CPHS # 2010-01-619). The icddr,b's Research Administration Office reviewed the decision and approved it (activity number ACT #00289, grant number GR #0616).

To assess knowledge acquisition, the study team administered a pre and post training survey to all TBAs. These surveys were the same other than the fact that the post training survey did not collect background information on the TBAs. Knowledge retention was assessed by using the same post training survey instrument 6 and 18 months after implementation of the new clean delivery kit. The knowledge-based surveys were designed to describe the TBAs' background characteristics (pre training survey only), as well as changes in knowledge, attitudes, and practices related to the two interventions, particularly changes related to critical knowledge. We define 'critical knowledge' as knowledge related to reason for misoprostol use, timing, dosage, and route of administration, warning signs, utility of the mat, and timing for patient transfer. Examples of the questions asked in the survey include the following: "How many tablets of misoprostol should be given to prevent excess bleeding?", "Before you give a woman misoprostol tablets, what should you check?", and, "If a woman is bleeding a lot, how do you determine *how much* blood a woman has lost?" The TBAs from one of the six intervention sites were trained off the training cycle, thus researchers were not able to administer the pre/post training survey to them. Because data from all four data collection points are not available, we did not include these 97 trained TBAs in this analysis.

Data on TBAs' delivery practices were captured in postpartum interviews with mothers who had recently delivered. The interviews used a structured questionnaire administered to every 20th woman who delivered during the intervention and covered interviewees' background information, knowledge of PPH and misoprostol, pregnancy history, and information on the index pregnancy. Examples of questions asked in the questionnaire include: "Where did you receive information about misoprostol?", "Where did you deliver?", and, "Were you referred?" We stopped collecting data after completing 3016 interviews, at which point we began analyzing the results to meet the funder's dissemination deadline; deliveries continued to take place in the study though. Verbal autopsies were carried out for all maternal deaths in the project area and results from these interviews were also used to assess TBAs' practices. All data were entered using Epi Info™ version 3.5.1 (Centers for Disease Control and Prevention, Atlanta, Georgia, USA) and analyzed in STATA® version 11.0 (StataCorp, LP, College Station, Texas, USA) (StataCorp, 2009).

To determine whether changes in TBAs' responses between survey administrations were statistically significant, we use a two-tailed *z*-test for comparison of two proportions. To assess changes in practices, researchers used the postpartum interview results. Investigators again used the two-tailed *z*-test for two-sample test of proportion to determine whether differences in misoprostol and mat use were statistically significant based on who attended the delivery (i.e. RDRS TBA versus other). The confidence level was set at $p = 0.05$ for all analyses.

Results

Background of TBAs

As seen in Table 1, the average TBA was married, 47 years old, and had 1.9 years of formal schooling. On average, TBAs had been conducting deliveries for 11.7 years, with an average of 5.5 deliveries per month. Of TBAs who had previously received non-RDRS training, most had received government training. Only 1.3% of the TBAs had never received training prior to the intervention.

Table 1
Demographic characteristics of TBAs prior to intervention training ($N = 461$).

A	**Mean**	**Range**
Age	46.6	20–78
Years of School	1.9	0–11
Years as TBA	11.7	0–40
Deliveries per month	5.5	0–12
B		**(%)**
Marital Status		
Single		0.4
Married		64.4
Divorced/widowed		32.3
Institution responsible for previous training		
Government		32.3
RDRS		95.9
Other NGO		14.1
Other		2.6
No prior training		1.3

Knowledge of misoprostol

Prior to the training, very few TBAs identified misoprostol as a way to prevent excessive bleeding; 88.5% of TBAs reported that they did not know of any way to prevent excessive bleeding (Table 2). Immediately after the training, a significantly higher proportion of TBAs reported that they knew a way to prevent excessive blood loss ($p < 0.0001$) and listed misoprostol as the means of doing so ($p < 0.0001$) (Table 2). At 6 months and 18 months after implementation, the percentage of TBAs listing misoprostol as a way to prevent excessive bleeding increased further, of which the increase between 6 and 18 months was statistically significant ($p < 0.0001$) (Table 2).

As seen in Table 3, the percentage of TBAs who reported that misoprostol "prevents/reduces bleeding after delivery" increased significantly from pre training to post training ($p < 0.0001$), and remained high at 6 months and 18 months after training. Knowledge of correct dosage, correct route of administration, and correct timing remained high at the three post training survey administrations: nearly all TBAs knew to administer 3 tablets orally immediately after delivery of the baby (Table 3). The percentage of TBAs who responded with the correct dosage ($p < 0.0001$), correct route ($p < 0.0001$), and correct timing ($p < 0.0001$) all increased significantly from pre training levels (Table 3).

When asked immediately after the training and at 6 months post implementation if there is anything TBAs should check before administering misoprostol, a significantly higher proportion of TBAs stated that they should check that the baby is delivered ($p < 0.0001$ and $p < 0.0001$, respectively). Similar results were seen in response to the need to check that there is no twin ($p < 0.0001$ and $p = 0.01$, respectively) (Table 3). At 18 months post implementation, the percentages dropped slightly but not significantly ($p = 0.64$ and $p = 0.29$, respectively) (Table 3). Few TBAs initially stated that they should *not* administer misoprostol to a woman while she is still pregnant. Immediately after the training, nearly all TBAs stated this, a statistically significant increase ($p < 0.0001$). At 6 months, and 18 months after implementation, all TBAs stated that they should not administer misoprostol to a woman while the woman is still pregnant, citing risks such as uterine rupture, maternal death and/or fetal death (Table 3).

Knowledge of mat

Before the training, less than 1% of TBAs identified the delivery mat as a way to determine how much blood had been lost; the mat was not available prior to the training so these responses were likely guesses (Table 3). After the training, more than 90% of TBAs

Table 2
Percent of TBAs with general knowledge of delivery before and after the training.

	Immediately before training	Immediately after training	6 months after implementation	18 months after implementation
	$N = 461$	$N = 464$	$N = 491$	$N = 448$
Do you expect your knowledge and skills to improve after this training? If yes, why?[a]				
No	0.0	0.0	0.0	0.0
Yes, because of learning new things	90.2	96.6*	99.2**	91.7***
Yes, because will correct mistakes	39.1	52.6*	59.9**	66.7***
Yes, because will refer patients promptly	1.1	28.5*	43.2**	32.6***
Yes, for some other reason	7.4	7.8	7.7	14.7***
Do you know a way to prevent excessive bleeding after delivery?				
Yes	11.5	94.4*	99.2**	96.9***
Ways to **prevent** excessive bleeding (spontaneous)[a]				
Put baby to the breast immediately	1.7	0.6	2.0	0.2***
Uterine massage	0.4	1.9*	1.0	0.0
Give her misoprostol tablets	3.0	84.7*	88.4	96.9***
Refer the woman to hospital	4.1	7.5*	9.8	0.0***
Some other way	3.3	0.6*	0.0	0.0

*Statistically significant change between pre and post training survey administration based on $p = 0.05$.
**Statistically significant change between post training and 6 month survey administration based on $p = 0.05$.
***Statistically significant change between 6 and 18 month survey administration based on $p = 0.05$.
[a] Categories are not mutually exclusive.

Table 3
Percent of trained TBAs with knowledge of misoprostol and mat before and after the training.

	Immediately before training	Immediately after training	6 months after implementation	18 months after implementation
	$N = 461$	$N = 464$	$N = 491$	$N = 448$
Misoprostol knowledge				
What does misoprostol do?[a]				
Prevents/reduces bleeding after delivery	6.7	98.5*	99.2**	100.0***
Helps placental delivery	1.3	85.6*	95.3**	100.0***
Does other	2.0	8.6*	23.0**	0.9***
How many tablets of misoprostol should be given to prevent excessive bleeding?				
3 tablets	0.4	99.6*	95.5**	98.4***
How do you administer the misoprostol tablets to prevent excess bleeding?				
Ask her to swallow the tablets	4.3	99.6*	100.0**	100.0
When do you give the misoprostol tablets to prevent excess bleeding?				
Immediately after the delivery	6.3	96.8*	100.0**	99.3***
Before you give a woman misoprostol tablets, what should you check?[a]				
Make sure the baby is out	1.5	57.9*	80.4**	79.2
Make sure there is no twin	1.1	77.6*	84.5**	81.9
If you give a woman misoprostol, what side effects may occur?[a]				
Shivering	0.0	65.9*	82.7**	91.5***
Fever	0.4	89.0*	79.0**	84.4***
Nausea	0.9	81.7*	76.2**	85.7***
Diarrhea	0.0	48.9*	59.5**	26.8***
Other	1.5	13.6*	4.7**	0.0***
When should you not give a woman misoprostal tablets?				
While the woman is still pregnant	4.1	99.4*	100.0**	100.0
If you give misoprostol before the baby is delivered, what might happen?[a]				
Mother could die	0.4	90.5*	93.3	85.5***
Baby could die	1.1	90.5*	92.3	79.5***
Uterus could rupture	0.2	28.9*	12.6**	7.8***
Nothing – baby and mother will be fine	0.2	0.4	0.0	1.6***
Other	1.3	6.3*	5.9	0.9***
Mat knowledge				
If a woman is bleeding excessively, how do you determine how much blood she has lost?[a]				
Visual observation	84.6	10.8*	20.4**	14.5***
Put a cloth under her	13.2	3.0*	1.0**	9.2***
Put a plastic sheet under her	4.8	3.7	1.6**	6.0***
Observe symptoms of mother	24.5	6.0*	11.6**	6.3
Soaking status of mat	0.4	92.7*	97.8**	96.9
Other	15.4	1.1*	0.2	0.0
Don't know	0.9	0.2	0.0	0.0
What do you do if a woman is bleeding heavily after delivery?[a]				
Refer her to a facility	92.8	92.5	96.7**	98.9***
Treat complications at home	5.4	0.4*	0.2	0.2
Give misoprostol	0.7	6.9*	3.1**	0.9***
Nothing/wait and see	0.0	0.0	0.0	0.0
Other	0.7	0.2	0.0	0.0

*Statistically significant change between pre and post training survey administration based on $p = 0.05$.
**Statistically significant change between post training and 6 month survey administration based on $p = 0.05$.
***Statistically significant change between 6 and 18 month survey administration based on $p = 0.05$.
[a] Categories are not mutually exclusive.

Table 4
Percent of mothers reporting use of mat or misoprostol by attendant at delivery.

	RDRS TBA	Untrained TBA	Relative	Nurse	Doctor	Alone
	$N = 1280$	$N = 762$	$N = 386$	$N = 287$	$N = 236$	$N = 65$
Used mat	80.3	68.4*	63.2*	33.4*	7.6*	66.2*
Used misoprostol	81.3	69.9*	64.8*	43.2*	7.6*	67.7*

*Statistically significant difference between trained RDRS TBA group and all others based on $p = 0.05$.

reported the soaking status of the mat as their means of determining blood loss, which was a statistically significant increase ($p < 0.0001$). This percentage increased further at 6 months ($p < 0.0001$) and remained high at 18 (Table 3).

Practices reported by mothers after delivery

Out of a total of 3016 mothers interviewed after delivery, 1280 (42.4%) were attended by an RDRS TBA. Among those who delivered with an RDRS TBA, over 80% took misoprostol, which was statistically significantly higher compared to the percent who took misoprostol who delivered with an untrained TBA (i.e. not an RDRS TBA who received training on the intervention tools) ($p < 0.0001$), a relative ($p < 0.0001$), a nurse ($p < 0.0001$), a doctor ($p < 0.0001$), or no one ($p = 0.01$) (Table 4). Incorrect timing of misoprostol administration was overall very low, reported in 0.1% of women who had TBAs assist them, and 0.3% across all other groups (data not shown).

Use of the delivery mat was very high. Among women who delivered with an RDRS TBA, significantly more used the mat compared to women who deliver with an untrained TBA ($p < 0.0001$), a relative ($p < 0.0001$) or alone ($p < 0.0001$) (Table 4).

In total, 476 women (15.8%) were referred to a facility due to complications, 29.8% of whom were referred by an RDRS TBA (data not shown). A total of 113 maternal deaths were recorded out of 77,337 home deliveries during the intervention (data not shown). Of those, 108 deaths were due to obstetric causes: PPH and bleeding-related causes ($n = 36$), antepartum hemorrhage ($n = 8$), eclampsia in combination with other causes ($n = 39$), obstructed labor ($n = 2$), complications due to cesarean delivery ($n = 1$), and other direct causes ($n = 22$). Of the 36 women who died as a result of PPH and bleeding-related causes, 16 had taken misoprostol for prevention of PPH. The two women who died due to ruptured uterus did not take misoprostol. Further review of the verbal autopsies revealed that of the 113 deaths, only 12 deliveries were assisted by trained RDRS TBAs. Of those 12, none had died of PPH, and all were transferred to the nearest facility following the protocol explained during the training. In other words, we could not link these deaths to harmful practices or attitudes of the attending TBAs.

Clients expressed an overwhelming acceptance of the interventions, as indicated by women's responses during their interview (data not shown). Among women who were offered misoprostol, 98.6% stated they would recommend it to other pregnant women, and 84.6% said they were willing to pay for misoprostol in future pregnancies. In reference to the mat, 97.9% of those who used it said it was beneficial, and 84.8% of women who received it in the clean delivery kit said they were willing to use the mat in the future. In addition, 97.4% of women who received the mat were willing to pay for it in future pregnancies.

Discussion

To our knowledge, this is the largest TBA training study that has tracked knowledge, attitudes, and behaviors of TBAs related to use of misoprostol and a blood measurement tool over an 18 month period. During this time, the participating TBAs demonstrated an impressive capacity to acquire and retain new knowledge, despite an average educational attainment of less than two years of school.

More than 9 out of 10 TBAs—and often a much higher proportion than that—had acquired all critical knowledge, as is evident from the survey administered immediately after the training. Almost 100% of TBAs spontaneously recalled that misoprostol "prevents/reduces bleeding after delivery" and explicitly stated not to give a woman misoprostol while she is still pregnant. TBAs also understood the possible serious adverse events associated with incorrect timing of administration. More importantly, 6 months and 18 months after implementation, knowledge in nearly all critical areas had not only been retained, but had actually increased. Knowledge about correct timing of administration increased significantly to 100% and remained high at 18 months (99.3%). Furthermore, 100% of TBAs were able to correctly state how misoprostol works. At 18 months, nearly all TBAs (98.4%) still knew the correct dosage, and 100% of TBAs still mentioned not to administer misoprostol while the woman is pregnant when asked about any necessary precautions to take.

In addition, the results demonstrate that women whose home deliveries were attended by a trained RDRS TBA had a significantly greater chance of using misoprostol, and using it correctly, as well as a significantly greater chance of using the mat. We conclude that supervised TBAs can be trained to safely and effectively use these two interventions at home births.

Despite the benefits of misoprostol in reducing blood loss after delivery, misoprostol is a drug that can be harmful if used incorrectly. If it is administered for PPH prevention before delivery, or between the deliveries of twins, it can endanger the health, and perhaps the lives, of both mother and child. In addition, there are potential side effects, like shivering, fever, nausea, and vomiting, associated with even correct use of misoprostol. Shivering and fever occur significantly more frequently among misoprostol users than a placebo group, but the benefits of misoprostol use for the prevention of PPH outweigh the associated risks of side effects (Patted et al., 2009). While unpleasant, these side effects are not dangerous to mother or child; they are transient and can be managed at the household level (Derman et al., 2006; Mobeen et al., 2011).

Limitations

Our study does have some limitations. Unfortunately, we do not have a complete set of TBA knowledge-based surveys for analysis. The total number of TBAs responding to the survey varied across administrations and the 18 month survey administration had the smallest group with only 448 TBAs. For the analysis, we used group proportions to compare changes between surveys, and could not match patient and TBA records. Data from women's postpartum interviews were based on self-reported information; neither the study team nor the CHW supervisors were able to verify by direct observation what occurred at the time of delivery. In addition, we were not able to confirm that women being referred for excessive bleeding who used the mat were referred once the mat was full. This would have been useful information to illustrate that the mat was being used as a guide for blood loss measurement. The inability to document (and confirm) the complications that arose, and to observe the behavior of TBAs and clients in response to those complications, limit the strength of our findings.

Another important point to note is that the use of one of the new interventions possibly prompted the use of the other, aiding in the retention of knowledge. Therefore, we are not sure if the success of this intervention is dependent upon the combined use of both interventions.

Additionally, the intervention was laid on top of RDRS's well-established and respected maternal health program. We simply retrained existing TBAs to be part of the community-based distribution of misoprostol and the mat. Our relationship with RDRS was a strength of the study because it helped to increased TBA accountability and protocol adherence, but it limits our ability to generalize our results outside of similar contexts. Furthermore, the specific monitoring and evaluation requirements within the context of our study may have had unanticipated positive impacts on outcomes due to increased TBA supervision and greater presence of TBAs in the served communities. We do not know if in a different environment, different results would emerge.

Lastly, the women who delivered with RDRS TBAs were not randomized to do so. Women self-selected to contact RDRS TBAs at the time of delivery, thus these women could be inherently different from women that did not deliver with an RDRS TBA. It is possible that the increased utilization of misoprostol and the mat among women who delivered with RDRS TBAs may be partially due to differences in these women and their knowledge of or inclination to use these technologies. The data do not allow us to refute this possibility. Despite these limitations, our study provides strong evidence that TBAs can safely and effectively be involved in the community-based distribution of these two interventions.

Conclusion

Integrating TBAs into a functioning formal health care system, providing adequate training, refresher trainings, and supervision, and supplying them with effective technologies like misoprostol and blood measurement tools should be a key part of safe motherhood initiatives wherever these criteria can be met. In the past, TBAs lacked effective technologies that could prevent PPH during home deliveries. The results of this training program illustrate that TBAs can effectively be trained to use these two technologies to prevent and manage PPH. RDRS TBAs conducted over 5 deliveries per month, on average, which allowed them to regularly practice the preventative use of misoprostol and the mat. In this way, TBAs' knowledge of the interventions stayed fresh after training and was reinforced in the field. By training TBAs to use these two interventions, RDRS has taken important steps to provide TBAs with life-saving tools.

As long as the need for skilled attendance exceeds the resources for maternal healthcare, deliveries will continue to take place at home without SBAs. Given this likelihood, any simple, task-shifting intervention that can be taught to birth attendants who will be present during home deliveries is worthy of serious consideration. Our data indicate that both interventions were acceptable to TBAs and clients, and that TBAs used the two interventions appropriately and effectively in the field. Maternal health policies need to be re-examined to take into account the significance of appropriate and applicable low cost community-based interventions. Particularly in many South Asian and sub-Saharan African countries, the recent trend has been toward devaluing TBAs. We propose a reevaluation of recent evidence and suggest the use of this program as a model to be adapted to other regions of the world where, unfortunately, high coverage of SBAs remains a distant goal.

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