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A Community-Based Continuum of Care Model for the Prevention and Treatment of Postpartum Hemorrhage in Low Resource Settings

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World Health Organization (WHO) estimates that 358,000 women died in pregnancy or childbirth in 2008, which is a 34% decline in maternal mortality globally since 1990[1]. Despite this decline, low resource countries, where women deliver at home or in rudimentary health facilities, continue to account for 99% of maternal deaths. The most common cause of preventable maternal mortality and morbidity in these countries is postpartum hemorrhage (PPH)[2].

Numerous challenges to the prevention and treatment of PPH exist in low resource countries. These include unavailability of skilled health care providers, lack of uterotonics and cold storage, minimal or incorrect practice of the principles of active management of the third stage of labor, underestimation of blood loss and, finally, deficiencies in the communication and transportation infrastructure which impede transfer to a higher level of care. In addition, four delays in response to obstetric complications represent key contributors to maternal mortality and inhibit appropriate provision of care in cases of PPH. They are: (1) delay in problem recognition (inability to quantitate accurately the amount of blood loss); (2) delay in deciding to seek assistance from skilled obstetric care providers; (3) delay in reaching a facility that can provide life-saving treatment; and (4) delay at that facility in providing quality emergency treatment[3]. Such delays must be overcome on a regular and continuing basis in order to reduce the burden of morbidity and mortality from PPH that exist in remote settings.

A continuum of care model for PPH (CC-PPH) incorporates multiple strategies to address the full spectrum of clinical, social and system factors related to morbidity and mortality from PPH in low resource settings[4]. The main components of this model (Figure 1) are: (1) community mobilization; (2) the routine use of prophylactic misoprostol or other appropriate uterotonics; (3) early and accurate identification of excessive blood loss; (4) availability of a non-pneumatic anti-shock garment (NASG); (5) systemization of communication, transportation and referral to higher-level facilities; and (6) access to quality, appropriate and timely comprehensive emergency obstetric care (CEmOC). In this chapter, we present a CC-PPH model which can be implemented to address the factors that lead to unnecessary maternal deaths in low resource settings.

IMPLEMENTING CONTINUUM OF CARE MODEL FOR POSTPARTUM HEMORRHAGE IN LOW RESOURCE SETTINGS

Community mobilization

The first component of the CC-PPH model is community mobilization. Community awareness about the four delays and health interventions that can prevent and treat PPH are necessary for women to access life-saving EmOC. Community mobilization is a 'capacity-building process through which community individuals, groups, or organizations plan, carry out, and evaluate activities on a participatory and sustained basis to improve their health and other needs, either on their own initiative or stimulated by others'[5].

Community mobilization/ raising awareness	All births	If excessive bleeding continues	If woman develops signs of shock	Referral
Develop emergency communication/transport referral plan →	Administer uterotonics Measure blood loss →	Alert transport systems and prepare for transport →	Apply non-pneumatic anti-shock garment (NASG) →	Refer and transport to emergency obstetric care

Figure 1 Continuum of care model for postpartum hemorrhage

Community mobilization involves developing an ongoing dialogue between community members about their health issues, empowering the community to address its own health needs, and working in partnership with the health care system to create locally appropriate responses to community health needs[5].

The success of effective and sustainable community-based health interventions is often attributed, at least in part, to an ability to engage and maintain the trust of community members[6–8]. Health providers, non-governmental organizations (NGOs) and ministries of health (MOHs) can provide unique opportunities to identify and build on the assets and resources that already exist in collaboration with communities. Advocacy with government officials and key stakeholders is a necessary step for fostering sustainability and scaling up of community health interventions.

Successful community mobilization requires multiple methods at the community and national level to increase the acceptance and adoption of health interventions. Raising awareness about PPH can promote an understanding of the existing barriers faced in accessing EmOC and mobilize the community to identify strategies that may improve maternal health outcomes. Birth and complication readiness plans can address the first three delays, in recognizing the problem, in deciding to seek care, and in reaching the facility. Community transport plans can be collaboratively developed by community members and health facilities within each neighborhood or village so that families can be prepared when emergencies arise.

One of the authors of this chapter, Stacie Geller, has described the community mobilization activities conducted prior to and throughout the introduction of the use of misoprostol and the blood collection drape for the prevention and early diagnosis of PPH in collaboration with the Millennium Villages Project in rural Ghana. The CC-PPH model was presented to key opinion leaders such as chiefs, religious leaders, senior women, assemblymen, herbalists and traditional birth attendants (TBAs) to establish rapport and obtain community support. Focus group discussions were held with local women's groups such as pregnant and nursing mothers, and those who experienced PPH in their last deliveries. Key opinion leaders developed community sensitization messages to increase awareness of and knowledge about PPH, misoprostol and the blood collection drape (for prompt recognition of excessive bleeding). TBAs, community health educators (CHEWs) and other health providers were also trained on safe delivery and the use of misoprostol and the blood collection drape. Educational materials such as pamphlets, brochures, posters and pictorial flipcharts were developed to provide education about PPH and the danger signs related to hemorrhage. Using these strategies and tools, CHEWs, TBAs and midwives mobilized their communities to make specific plans for emergency response (transport, savings to pay for fuel and facility fees, blood donation) and to take prompt action if PPH were to occur. It is critical to involve the entire community in order to improve individual access to EmOC, and community mobilization should be prioritized as a key strategy in the CC-PPH model. Other components of the model will be more successful if the community is sufficiently engaged early in the process.

Use of misoprostol or other uterotonics

Administration of a uterotonic for prevention of PPH is the next component of the CC-PPH model. Oxytocin, the uterotonic of choice, is often not feasible in community-level settings without skilled attendants, cold storage or sterile equipment. For women delivering outside skilled facilities, misoprostol is accepted to be safe and effective in the prevention of PPH[9–12]. The International Federation of Gynecology and Obstetrics (FIGO) has endorsed misoprostol use for settings in which oxytocin is unavailable or in the absence of active management of the third stage of labor[13]. In such settings, WHO also recommends the administration of 600 μg oral misoprostol by a health worker trained in its use immediately after the birth of the baby[14,15] (see Chapter 42).

Multiple models exist for the distribution of misoprostol in community-level settings, and the appropriate model for each setting depends on the community infrastructure and national policies regarding use of misoprostol, as well as the availability of community-level providers. Misoprostol has been registered for use in PPH in 17 countries in Africa and Asia as of August 2010[16]; however; it has not yet been implemented as the standard of care for all community-level births in any of these countries. Pilot programs of community-based misoprostol distribution are underway, but only a few have been evaluated to date.

Two randomized double-blind placebo-controlled trials of 600 μg oral misoprostol administered by TBAs after delivery showed that misoprostol is associated with a significant reduction in the rate of PPH (blood loss of 500 ml or more)[9,11]. In a remote region of Pakistan, misoprostol was associated with a significant reduction in the rate of PPH in deliveries under the care of TBAs (16.5% vs. 21.9%; RR 0.76, 95% CI 0.59–0.97) compared with placebo. Additionally, significantly fewer women in the misoprostol group experienced a drop of more than 3 g/dl in hemoglobin compared with those in the placebo group (RR 0.53, 95% CI 0.34–0.83)[9]. These findings are consistent with an earlier community-based trial of misoprostol administered by auxiliary nurse-midwives attending births at home or in lower-level facilities in rural India, which showed a nearly 50% reduction in PPH (RR 0.53, 95% CI 0.39–0.74)[11].

In settings where terrain or weather prevents women from delivering in the company of birth attendants or where community-level health providers are barred from distributing medication, direct distribution of misoprostol to pregnant women may be the most feasible model for distribution. Two recent operations research studies of direct provision of misoprostol to pregnant women provide examples for

the implementation of this model[17,18]. These studies focused on program effectiveness, the acceptability of misoprostol and adverse effects, but did not aim to prove the efficacy of misoprostol to prevent PPH since it has been previously proven efficacious and safe.

A non-randomized comparative study of women in rural Afghanistan utilized semiliterate community health workers (CHWs) to provide three 200 μg tablets of misoprostol to 2039 women in the 8th month of pregnancy, along with an educational intervention to the women and their household support members on the correct and safe use of misoprostol[17]. In structured interviews conducted 1 week postpartum, all the women who took misoprostol ($n = 1421$) reported taking the drug after delivery of the baby. Women in the intervention group were significantly more likely to have reported experience of no side-effects compared with 1148 women in the control group who received usual care (60.3% vs. 18.6%). The authors stated that the high rate of adverse symptoms in the control groups was likely due to the use of herbal products.

Similarly, female community health volunteers (FCHVs) in rural Nepal distributed three 200 μg tablets of misoprostol to women late in pregnancy for self-administration at home births[18]. Program performance was evaluated through pre- and post-intervention household surveys and data collected by FCHVs and other health providers. The primary outcome was overall coverage with uterotonics among women with vaginal delivery, which significantly increased from 11.6% at baseline to 74.2% at the end of the study (OR 25.0, 95% CI 15.6–40.1). The mortality rate among misoprostol users was 72 per 100,000 compared with 292 per 100,000 among non-users, but the number of deaths by specific causes was too low to evaluate differences statistically. Misoprostol users were more likely to report shivering than non-users, but the difference was not statistically significant.

Administration of a uterotonic for prevention of PPH in a low resource setting is an important component of the CC-PPH model, but even with prophylaxis, some women experience PPH. The next steps in the CC-PPH model address identification of and response to excessive bleeding.

Accurate assessment of blood loss

Visual estimation of blood loss is notoriously inaccurate even among the most skilled health providers[19]. Family members and unskilled birth attendants are believed to perceive the signs of excessive bleeding during labor and postpartum only 11% of the time[20]. To address the delay in problem recognition, community-based health providers and family members need to acquire the necessary skills to recognize danger signs of excessive bleeding. A reliable blood loss detection method assists birth attendants rapidly to recognize excessive bleeding instead of waiting for changes in vital signs (blood pressure, pulse and pallor) and/or unconsciousness.

There are several novel approaches for timely and accurate assessment of PPH in low resource settings. The kanga, a garment used in Tanzania, is a standard sized rectangular cotton cloth used to absorb the blood during delivery. Two kangas have been found to hold slightly more than 500 ml when completely soaked, providing a convenient unit of measure that has been used to recognize PPH[21]. The kanga method can be adapted to other standardized cloths used in other countries such as the sari, dupatta, sarong or to manufactured absorbent pads. However, its utility would always be dependent on the user's judgment of degree of saturation.

The BRASSS-V blood collection drape (Figure 2), a low-cost calibrated and funneled collecting pouch attached to a plastic sheet, was developed to measure accurately postpartum blood loss at the time of deliveries taking place at home and in rudimentary facilities[22,23]. The drape is placed under the woman's buttocks immediately after delivery, and the two strings attached to the upper end of the drape are tied around the woman's abdomen to optimize blood collection. A randomized controlled study found a high level of correlation ($r = 0.928$) between the drape estimate and the 'gold standard' of photospectrometry, demonstrating the accuracy of drape collection[24]. In the same study, visual assessment underestimated postpartum blood loss by 33% compared with drape assessment (203 ml ± 147 ml vs. 304 ml ± 173 ml, $p < 0.001$)[24]. The drape has been used in multiple

Figure 2 The BRASSS-V blood collection drape

research studies worldwide which have validated its accuracy and ease of use as a practical tool to measure blood loss occurring during the third stage of labor[25,26] (see Chapter 9 and 11).

The blood mat (Figure 3), made of layers of cotton backed by plastic and developed by Dr Abdul Quaiyum, a researcher at the International Centre for Diarrhoeal Disease Research in Bangladesh (ICDDRB), also has been used by families and community health workers to identify hemorrhage in women giving birth at home[27]. Dr Quaiyum received a grant from the Bill and Melinda Gates Foundation in 2010 to develop and test a biodegradable birth mat that can only absorb 500 ml of fluid[28]. Placed under the mother immediately after birth, if the mat stops absorbing blood, it indicates that the mother has bled more than 500 ml, and that she should be referred immediately to a higher-level facility.

Almost any type of fabric or calibrated container can be used to measure blood loss in low resource settings. However, the key factor is standardization and validation of measurement. Regional or local groups of health educators or workers can fashion pads, mats or kangas out of locally acquired materials. They can then take a measured amount of fluid and determine what amount saturates the material. As long as these homemade pads are made of similar materials in absorbency and size, then a somewhat more accurate assessment of blood loss can be made.

Earlier detection of excessive blood loss means earlier action to provide medical management and/or transfer the woman to a higher-level facility. Even with primary prophylaxis and early detection of PPH, however, a woman may continue to bleed and progress into shock. Delayed diagnosis and treatment of continuing blood loss in combination with underestimation may quickly lead to hypovolemic shock, cardiopulmonary arrest and death[29]. The non-pneumatic anti-shock garment (NASG), the fourth component of the CC-PPH model is used to resuscitate and stabilize women in shock until comprehensive care for PPH is available.

Figure 3 The blood mat in use by Pathfinder International staff in Bangladesh. Photo courtesy of Suellin Miller

Figure 4 Use of non-pneumatic anti-shock garment. Photo courtesy of Suellen Miller

Non-pneumatic anti-shock garment

The NASG addresses the delay in reaching the facility by keeping the woman stable long enough to be transported and seek further treatment. It is a lightweight, inexpensive, reusable, first aid device which decreases blood loss and restores vital signs (Figure 4).

When applied in the community or home, it can improve circulation to the core organs and decrease bleeding while the woman is awaiting transport, being transported or during delays in receiving care at higher-level facilities. The NASG is not therapy or treatment for PPH, but it can be used to buy time to obtain definitive treatment. Family members, TBAs, CHWs, rural auxiliary nurses and even ambulance or conveyance drivers can quickly and easily be trained to apply the NASG tightly enough to improve the woman's status without causing harm[30]. The device can be worn over clothing, no inflation is required and it can be re-used up to 40 times (see Chapter 39).

If the NASG has been placed as a first resuscitative measure, the health provider should call for help, assess vital signs and, if possible, find the source of bleeding, and, if the cause is uterine atony, provide uterotonics. The NASG should be removed only under skilled supervision in a facility setting where vital signs can be monitored and there are adequate intravenous fluids and other required treatments. Barriers to implementation include initial skepticism about the NASG's ability to resuscitate women with hypovolemic shock secondary to obstetric hemorrhage, resistance to change and implementation of new behaviors, and lack of knowledge or previous contact with the NASG in medical training[30].

As with any new device or new procedure, the NASG requires training and then modification of use depending on context. However, there are instances where use has been adapted in ways that have not been supported by evidence, and, in fact, may be harmful. For example, after clinical trials were conducted with the NASG following strict protocols in four states in Nigeria, the NASG is now used more widely across the country in the context of Pathfinder International's Clinical and Community Actions to Address PPH. While the protocol for placing a woman in the NASG in Pathfinder training materials is to place the device on a woman with estimated blood loss of at least 500 ml and one sign of hypovolemic shock[31],

nurses and midwives in facilities in Nigeria have been seen placing NASGs on women who might be at risk for hemorrhage after the delivery. Instead of using it as a first-aid stabilizing device, it is being used prophylactically. To date, no evidence has been reported on its efficacy for preventing PPH, or whether there are negative effects for women who are not in shock receiving a device intended for shock. Because the NASGs can cause harm to hypovolemic women if removed prematurely or in the wrong sequence, placing the NASG on someone who is not in shock and then removing it rapidly or incorrectly might cause, at the very least, a vagal response. Finally, as the number of NASGs in any facility is limited, using one on a non-shock patient may mean there is none available if a severely shocked patient needed it.

Another potential problem being reported from field work at the time of this writing is the possibility of complacency among providers who, upon seeing the dramatic decrease in bleeding and restoration of vital signs in a woman with hemorrhage/hypovolemic shock, may lose the sense of urgency in referral to a higher level or in providing definitive hemorrhage/shock therapies[32,33]. This must be stressed in training and use. The NASG is not treatment; it only buys time. Transport and obtaining definitive treatment should never be delayed.

Addressing barriers to communication and transportation

Spatial barriers, such as distance or rough terrain, may pose significant obstacles to timely referral of women with PPH to CEmOC facilities[34,35]. Problems related to communication with skilled providers as well as transportation to higher-level facilities must be addressed at both national and local levels. Innovative strategies for addressing delays in communication and transportation have been implemented in several low resource countries.

In 2002, the government of Mali launched a nationwide maternity referral system to improve access to CEmOC through improved radio communications between community and district health facilities, improved ambulance service and community cost-sharing programs[35,36]. In women treated for obstetric emergency, the risk of death was reduced by 50% 2 years after the intervention was implemented, compared with the year before the intervention (OR 0.48, 95% CI 0.30–0.76)[35]. Although the program was national, each region and district developed their own local system through collaborations that ensured broad community support and sustainability.

Four-wheel drive ambulances and a radio communication system in Bo, Sierra Leone, increased the number of obstetric emergency cases transferred to hospitals resulting in the case fatality rate dropping by 50% from 20% (3 of 15) in the 16 months before the intervention to 10% (4 of 41) under the new system[37]. A cluster-randomized study in rural Pakistan examined the impact of a multifaceted intervention to improve education, communication and transportation on maternal and neonatal outcomes. In the intervention areas, local owner/operators of public transport vehicles trained to use stretchers and wireless telecom systems allowed TBAs and drivers to communicate with health facilities. Perinatal mortality among women in the intervention area was half that of women in the control area (adjusted OR 0.5, 95% CI 0.3–0.7)[38]. Other strategies for improving transportation have utilized motorcycles[39], local public bus systems[40], flagging systems along existing truck routes and networks of on-call volunteer drivers from the community[41].

Each local setting has its own unique social, cultural, economic, geographical, political and health systems factors which must be addressed in order to facilitate communication and transportation to facilities that provide higher levels of care. Once a women experiencing excessive bleeding reaches a skilled facility, health care providers must be trained and equipped to provide prompt quality CEmOC. Many countries are also investing in ambulance services; how well they facilitate the transfer and referral of women has not yet been documented.

Comprehensive emergency obstetric care

The final phase of a CC-PPH strategy addresses the delay at the facility in providing quality, definitive emergency treatment. All women need access routes and plans to bring them to EmOC services, because pregnancy complications often cannot be predicted or prevented. A basic EmOC (BEmOC) facility provides six 'signal functions', which are to (1) administer parenteral antibiotics; (2) administer parenteral oxytocics; (3) administer anticonvulsants; (4) perform manual removal of placenta; (5) perform removal of retained products; and (6) conduct assisted vaginal deliveries. A CEmOC facility will offer surgical services, such as cesarean sections, and blood transfusions in addition to the same procedures that are provided at a BEmOC facility.

UNICEF, WHO and UNFPA[42] issued a set of six process indicators to monitor the availability, utilization and quality of EmOC. The six process indicators are: (1) amount of EmOC services available; (2) geographical distribution of EmOC facilities; (3) proportion of all births in EmOC facilities; (4) met need for EmOC services; (5) cesarean sections as a percentage of all births in the population; and (6) case fatality rate. An analysis of 24 national or near-national needs assessments in 2006 showed that all but two countries met the minimum acceptable level of one CEmOC facility per 500,000 population[43]. Despite this progress, quality of care and geographical distribution of EmOC facilities were still a concern. CEmOC facilities were typically located in urban areas and not readily available for women in rural communities. BEmOC facilities were also not consistently available in sufficient numbers in relation to the size of the population and the majority of facilities offering

maternity services were not able to provide the full array of signal functions to qualify as EmOC facilities.

Despite the increasing recognition of the importance of EmOC services, several additional challenges exist in accessing quality care in low resource settings, such as overburdened health facilities, shortages of physicians and nurses, poor retention of skilled personnel, lack of operating theaters and emergency equipment, drug shortages, poor sanitation, hospital fees and availability of blood supplies[41,43,44]. If deaths due to pregnancy and delivery are to be substantially reduced, women with complications must have prompt access to quality EmOC. This entails supplying and equipping health facilities appropriately, training health staff to manage obstetric complications and ensuring that a functioning referral system is in place which links peripheral facilities to district health facilities or referral centers that can provide EmOC. Investment by government, ministries of health, NGOs and others in improving access to quality EmOC services has the potential to significantly reduce maternal and child mortality, especially in rural communities that are particularly vulnerable.

CONCLUSION

Many real and perceived barriers hinder accessing medical care, particularly for women in rural areas of low income countries. The high rates of maternal mortality and morbidity in low resource settings are the product of the institutional, environmental, cultural, financial and social barriers to providing skilled care and to preventing, recognizing and managing PPH. No single intervention can prevent PPH-related morbidity and mortality. Having said this, however, we believe a multifaceted, systematic, contextualized PPH continuum of care approach that addresses all factors directly contributing to maternal death from hemorrhage is essential if progress is to be made in this area. Commitment and support from key stakeholders, governmental organizations and policymakers will ensure the feasibility, acceptability and sustainability of evidenced-based interventions, including use of misoprostol, blood collection drape and NASG. Community involvement in developing communication and transportation systems will hopefully address the delays in hemorrhage recognition, stabilization and early management of women with shock and hemorrhage. We believe that the continuum of care model for the prevention and management of PPH may offer promise to improve health care delivery and has the greatest impact for saving women's lives, decreasing maternal morbidity and improving quality of life.

PRACTICE POINTS

- A CC-PPH model is essential to address the spectrum of clinical, social and system factors related to PPH morbidity and mortality in low resource settings
- Community engagement and mobilization can improve access to EmOC and educate the community about birth preparedness
- Use of a prophylactic uterotonic agent such as misoprostol can reduce the incidence of PPH
- Use of a reliable aid to the quantification of blood loss and the NASG can address the delay in recognition of the extent of hemorrhage and subsequent patient stabilization
- A reliable local emergency communication and transport system can facilitate consultation with skilled birth attendants, transfer of a woman to the CEmOC facility and alert staff to the need for prompt care.

References

1. WHO. Trends in maternal mortality: 1990–2008. Estimates developed by WHO, UNICEF, UNFPA, and the World Bank. Geneva: World Health Organization, 2010
2. WHO. Maternal Mortality. Fact Sheet No. 348. Geneva: World Health Organization, 2010
3. Maine D, Rosenfield A, Wallis M, et al. Prevention of maternal deaths in developing countries. New York: Center for Population and Family Health, 1999
4. Geller SE, Adams MG, Miller S. A continuum of care model for postpartum hemorrhage. Int J Fertil Womens Med 2007; 52:97–105
5. Howard-Grabman L, Snetro G. How to mobilize communities for health and social change. 2003. Health Communication Partnership. http://www.hcpartnership.org/Publications/Field_Guides/Mobilize/pdf
6. Fullilove RE, Green L, Fullilove MT. The Family to Family program: a structural intervention with implications for the prevention of HIV/AIDS and other community epidemics. AIDS 2000;14(Suppl 1):S63–7
7. Madison SM, McKay MM, Paikoff R, Bell CC. Basic research and community collaboration: necessary ingredients for the development of a family-based HIV prevention program. AIDS Educ Prev 2000;12:281–98
8. McCormick A, McKay MM, Wilson M, et al. Involving families in an urban HIV preventive intervention: how community collaboration addresses barriers to participation. AIDS Educ Prev 2000;12:299–307
9. Mobeen N, Durocher J, Zuberi N, et al. Administration of misoprostol by trained traditional birth attendants to prevent postpartum haemorrhage in homebirths in Pakistan: a randomised placebo-controlled trial. BJOG 2011;118:353–61
10. Hoj L, Cardoso P, Nielsen BB, Hvidman L, Nielsen J, Aaby P. Effect of sublingual misoprostol on severe postpartum haemorrhage in a primary health centre in Guinea-Bissau: randomised double blind clinical trial. BMJ 2005;331:723
11. Derman RJ, Kodkany BS, Goudar SS, et al. Oral misoprostol in preventing postpartum haemorrhage in resource-poor communities: a randomised controlled trial. Lancet 2006; 368:1248–53
12. Walraven G, Blum J, Dampha Y, et al. Misoprostol in the management of the third stage of labour in the home delivery setting in rural Gambia: a randomised controlled trial. BJOG 2005;112:1277–83
13. ICM/FIGO. Prevention and treatment of post-partum haemorrhage: new advances for low resource settings. ICM/FIGO Joint statement, 2006. www.pphprevention.org/.../FIGO-ICM_Statement_November2006_Final.pdf
14. WHO. WHO Statement regarding the use of misoprostol for postpartum haemorrhage prevention and treatment. Geneva: World Health Organization, 2009

15. WHO. Clarifying WHO position on misoprostol use in the community to reduce maternal death. Geneva: World Health Organization, 2010
16. Venture Strategies Innovations. Global miso map. http://vsinnovations.org/resources.html
17. Sanghvi H, Ansari N, Prata NJ, Gibson H, Ehsan AT, Smith JM. Prevention of postpartum hemorrhage at home birth in Afghanistan. Int J Gynaecol Obstet 2010;108:276–81
18. Rajbhandari S, Hodgins S, Sanghvi H, McPherson R, Pradhan YV, Baqui AH. Expanding uterotonic protection following childbirth through community-based distribution of misoprostol: operations research study in Nepal. Int J Gynaecol Obstet 2010;108:282–8
19. Dildy GA 3rd, Paine AR, George NC, Velasco C. Estimating blood loss: can teaching significantly improve visual estimation? Obstet Gynecol 2004;104:601–6
20. Sibley L, Caleb-Varkey L, Upadhyay J, et al. Recognition of and response to postpartum hemorrhage in rural northern India. J Midwifery Womens Health 2005;50:301–8
21. Prata N, Mbaruku G, Campbell M. Using the kanga to measure postpartum blood loss. Int J Gynaecol Obstet 2005;89:49–50
22. Geller SE, Patel A, Niak VA, et al. Conducting international collaborative research in developing nations. Int J Gynaecol Obstet 2004;87:267–71
23. Kodkany BS, Derman RJ, Goudar SS, et al. Initiating a novel therapy in preventing postpartum hemorrhage in rural India: a joint collaboration between the United States and India. Int J Fertil Womens Med 2004;49:91–6
24. Patel A, Goudar SS, Geller SE, et al. Drape estimation vs. visual assessment for estimating postpartum hemorrhage. Int J Gynaecol Obstet 2006;93:220–4
25. Sloan NL, Durocher J, Aldrich T, Blum J, Winikoff B. What measured blood loss tells us about postpartum bleeding: a systematic review. BJOG 2010;117:788–800
26. Schorn MN. Measurement of blood loss: review of the literature. J Midwifery Womens Health 2010;55:20–7
27. Prata N, Qualyum M, Shahed Hossain S, Azmil A, Bohl D. Community-based prevention of PPH in rural Bangladesh. Presented at the 138th Meeting of the American Public Health Association (APHA), Denver, CO, November 2010
28. Foundation funds 65 novel ideas to improve global health, from vaccines delivered in local cuisine to blankets of light for jaundiced newborns. 2010. Bill & Melinda Gates Foundation. http://www.grandchallenges.org/about/Newsroom/Pages/GCERound5Grants.aspx
29. Dildy GA 3rd. Postpartum Hemorrhage. Washington DC: American College of Obstetricians and Gynecologists, 1998
30. Berdichevsky K, Tucker C, Martinez A, Miller S. Acceptance of a new technology for management of obstetric hemorrhage: a qualitative study from rural Mexico. Health Care Women Int 2010;31:444–57
31. Pathfinder International. Prevention, recognition, and management of postpartum hemorrhage: trainer's guide. 2010. http://www.pathfind.org/site/DocServer/PPH_TG_final.pdf?docID=18682
32. Fathalla M, Mourad M, Meyer C, et al. Non-atonic obstetric hemorrhage: effectiveness of the non-pneumatic anti-shock garment in Egypt. J Obstet Gynaecol 2011; in press
33. Turan J, Ojengbede O, Fathalla M, et al. Positive Effects of the Non-pneumatic Anti-shock Garment on Delays in Accessing Care for Postpartum and Postabortion Hemorrhage in Egypt and Nigeria. J Womens Health (Larchmt) 2011;20:91–8
34. Le Bacq F, Rietsema A. High maternal mortality levels and additional risk from poor accessibility in two districts of northern province, Zambia. Int J Epidemiol 1997;26:357–63
35. Fournier P, Dumont A, Tourigny C, Dunkley G, Drame S. Improved access to comprehensive emergency obstetric care and its effect on institutional maternal mortality in rural Mali. Bull World Health Organ 2009;87:30–8
36. Pirkle CM, Fournier P, Tourigny C, Sangare K, Haddad S. Emergency Obstetrical Complications in a Rural African Setting (Kayes, Mali): The Link Between Travel Time and In-Hospital Maternal Mortality. Matern Child Health J 2010 [Epub ahead of print]
37. Samai O, Sengeh P. Facilitating emergency obstetric care through transportation and communication, Bo, Sierra Leone. The Bo PMM Team. Int J Gynaecol Obstet 1997;59(Suppl 2):S157–64
38. Midhet F, Becker S. Impact of community-based interventions on maternal and neonatal health indicators: Results from a community randomized trial in rural Balochistan, Pakistan. Reprod Health 2010;7:30
39. Hofman JJ, Dzimadzi C, Lungu K, Ratsma EY, Hussein J. Motorcycle ambulances for referral of obstetric emergencies in rural Malawi: do they reduce delay and what do they cost? Int J Gynaecol Obstet 2008;102:191–7
40. Shehu D, Ikeh AT, Kuna MJ. Mobilizing transport for obstetric emergencies in northwestern Nigeria. The Sokoto PMM Team. Int J Gynaecol Obstet 1997;59(Suppl 2):S173–80
41. Lee AC, Lawn JE, Cousens S, et al. Linking families and facilities for care at birth: what works to avert intrapartum-related deaths? Int J Gynaecol Obstet 2009;107(Suppl 1):S65–85, S86–8
42. United Nations Children's Fund. Guidelines for monitoring the availability and use of obstetric services. New York: United Nations Childrens Fund, 1997
43. Paxton A, Bailey P, Lobis S, Fry D. Global patterns in availability of emergency obstetric care. Int J Gynaecol Obstet 2006;93:300–7
44. Hofmeyr GJ, Haws RA, Bergstrom S, et al. Obstetric care in low-resource settings: what, who, and how to overcome challenges to scale up? Int J Gynaecol Obstet 2009;107(Suppl 1):S21–44, S44–5