A Continuum of Care Model for Postpartum Hemorrhage

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ABSTRACT: The leading cause of maternal mortality is hemorrhage, generally occurring in the postpartum period. Current levels of PPH-related morbidity and mortality in low-resource settings result from institutional, environmental, cultural and social barriers to providing skilled care and preventing, diagnosing and treating PPH. Conventional uterotonics to prevent PPH are typically not available or practical for use in low-resource settings. In such deliveries, most often taking place at home or in rural health centers, underestimation of blood loss leads to a delay in diagnosis. Deficiencies in communication and transportation infrastructure impede transfer to a higher level of care. Inability to stabilize a patient who is in hemorrhagic shock rapidly results in death. To address these individual factors, we propose a continuum of care model for PPH, including routine use of prophylactic misoprostol or other appropriate uterotonic, a standardized means of blood loss assessment, availability of a non-pneumatic anti-shock garment, and systemization of communication, transportation, and referral. Such a multifaceted, systematic, contextualized PPH continuum of care approach may have the greatest impact for saving women's lives. This model should be developed and tested to be region-specific. *Int J Fertil* 52(2–3):97–105, 2007

KEY WORDS: maternal mortality, maternal morbidity, postpartum hemorrhage, low-resource settings, continuum of care

INTRODUCTION

DESPITE 20 YEARS OF A SAFE MOTHERhood Initiative, the glaring disparities in maternal deaths between high and low resource countries remain. Ninety-nine percent of the 529,000 annual maternal deaths occur in the developing world where women frequently deliver outside of health care promoting facilities and without the assistance of skilled attendants.[1,2] The single most common cause of maternal mortality is hemorrhage, generally occurring postpartum and accounting for 25–33% of all deaths [3]. Given high rates of anemia in many populations and a lack of prompt and appropriate life saving treatment,

unexpected and untreated blood loss can very rapidly lead to death [2,4,5].

The leading cause of postpartum hemorrhage (PPH) is uterine atony, generally preventable by use of conventional uterotonic agents, among which oxytocin, an injectable medication that requires refrigeration, is preferred in hospital-based settings [6–8]. However, neither refrigeration nor safe injections are feasible in much of the developing world where the majority of births often occur at home or at inadequately equipped primary health care centers.

Active management of the third stage of labor (AMTSL), comprised of administration of a prophylactic uterotonic after delivery of the baby, delivery of the placenta by controlled cord traction, and uter-

ine massage reduces the occurrence of PPH when practiced by skilled birth attendants, but is not currently recommended in the absence of available uterotonics [9]. Although AMTSL performed by non-skilled attendants is not recommended, WHO recommends that in the absence of active management, uterotonics should be used alone for prevention of PPH [10–12].

Since the use of oxytocin requires the presence of skilled providers and the availability of sterile syringes and needles as well as refrigeration under varying heat conditions, other uterotonic agents such as oral misoprostol have been proposed and validated for use by less skilled birth attendants [7,11–14]. Oral misoprostol, 600 µg, is effective for prevention of PPH and feasible for use in at the community level areas, but has not yet been implemented as standard of care for prevention of PPH in low resource settings [15,16].

PPH generally occurs without warning and the majority of women who sustain a PPH present no risk factors [10,17]. Because home and community-based care providers may have only limited clinical and diagnostic skills, they may miss the earliest signs of hemorrhage, and diagnosis may be delayed until the woman shows unmistakable clinical signs of shock. A number of social, cultural, economic, and infrastructural obstacles, collectively known as the "three delays model," often are present between the onset of PPH and the woman receiving appropriate, quality Comprehensive Emergency Obstetrical Care (CEmOC) [18]. These delays include problem recognition (inability to estimate the amount of blood lost), difficulties in arranging for transportation and communication with the referral facility, and a lack of emergency first aid measures with which to keep the woman stable until a facility is reached. Often, by the time a woman arrives at a facility able to provide CEmOC, hypovolemic shock secondary to the hemorrhage has already led to oxygen deprivation and multiple organ failure [6,18–23].

Given the inability to predict who might experience this condition, reduction of PPH and associated morbidities and mortality requires multi-faceted solutions to adequately address the medical, social, gendered and systems factors that lead to unnecessary maternal deaths. No single intervention can solve this excess mortality and morbidity. A continuum of care approach that incorporates multiple strategies for PPH is necessary for deliveries that occur in women's homes and in rudimentary health facilities where highly skilled birth attendants and medical technologies are not available,

We propose a continuum of care model for PPH which includes a four-pronged strategy: (Figure 1) prophylaxis with misoprostol or another available and safe uterotonic agent for all births, a reliable method for blood loss assessment for early and accurate diagnosis when bleeding continues, community preparedness for complications that includes infrastructure/ mobilization to facilitate communication with and transfer to a higher level health care facility when further medical or surgical treatment is needed, and first-aid resuscitation and stabilization of women in shock during transport using a non-pneumatic anti-shock garment (NASG) [15,24,25]. We believe this multifaceted, systematic, contextualized continuum of care approach to PPH prevention and management may have the greatest impact for saving women's lives.

UTEROTONIC AGENT FOR PROPHYLAXIS

Where AMTSL is practiced, oxytocin is the preferable prophylactic uterotonic [6,7,26–31]. However, misoprostol is the acceptable alternative to oxytocin for prevention of PPH where safe injection is not possible since it can act as an effective uterotonic agent, is inexpensive (45 cents to $1.00 per dose depending on supplier), can be administered orally, does not require refrigeration, and has a long shelf life [32–36].

Figure 1: Continuum of Care Model for PPH

Community Preparedness\ Complication Readiness	All Births:	IF excessive bleeding occurs:	If woman develops signs of shock:	Referral:
Develop Emergency Communication/Transport and Referral Plan	Administer appropriate uterotonic/measure blood loss	Alert transport systems and prepare for transport	Apply NASG	Transport woman to highest level of care
⇨		⇨	⇨	⇨

A recent RCT in rural India tested oral misoprostol against standard of care (no uterotonic) for women delivering at home or in rural health facilities with Auxiliary Nurse Midwives (ANMs) [15]. This double blind randomized placebo controlled study was conducted in four primary health centers (PHC) serving 43 villages with a total population of 98,679 individuals. A single oral dose of 600 µg misoprostol or placebo was administered to all consented patients by the 19 ANMs within 5 minutes of delivery of the baby and the cutting of the umbilical cord. Results showed a significant decrease in acute PPH (>500 mL–999 mL) of 50% among those who were randomized to misoprostol and an 80% reduction in acute severe PPH (> = 1000). Overall, mean blood loss was reduced by 20% and blood loss in the second hour postpartum was reduced by 50%. Blood loss was measured in each delivery by use of the BRASSS-V drape. Maternal side effects of misoprostol were transient and clearly preferable to excessive hemorrhage, consisting primarily of shivering and slight fever with no evidence of neonatal adverse effects [15].

According to Holden & Campbell (2006), several countries either have registered misoprostol for PPH use (Nigeria), included it on the essential drug list (Ethiopia and Tanzania) or approved it by the Ministry of Health (India) [37–39]. However, to date misoprostol has not been broadly implemented for use in any of these countries at the community level. Because prophylactic use of misoprostol is not 100% effective in preventing all postpartum uterine atony, in low resource settings where expectant management is practiced, one can still expect an approximate 12% PPH rate [15].

Not all PPH is due to uterine atony. A 20-year observational study in India found that uterine atony accounted for only 54% of PPH [40]. A study of severe obstetric hemorrhage cases in 4 hospitals in Egypt found that among the women with postpartum bleeding only 60% were due to uterine atony [41]. Blood loss due to causes other than atony, such as lower genital tract lacerations, retained placental fragments and uterine rupture cannot respond to uterotonics, whether administered as a prophylactic or for treatment. Although these predisposing conditions can occur during any delivery, they may be more common among home deliveries attended by birth attendants who are unskilled or minimally trained [15].

Although administration of uterotonic prophylaxis is an important first step for prevention of PPH, it does not address the three delays that can
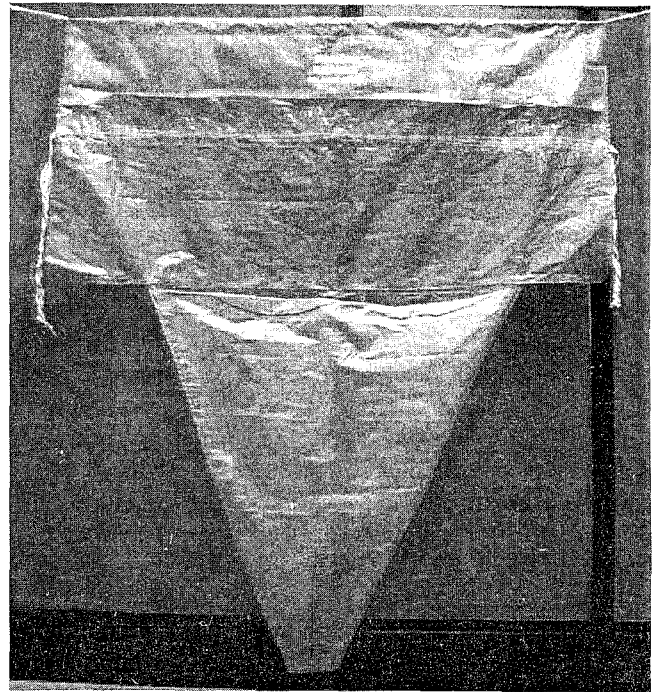

Figure 2: BRASSS-V Drape

occur as a result of PPH. This reality underscores the need for an early detection method to rapidly identify excessive blood loss, and other interventions necessary to decrease PPH and its associated morbidity and mortality when preventive measures are inadequate.

RELIABLE BLOOD LOSS DETECTION

Because PPH cannot be predicted, early recognition of excess bleeding is crucial in a strategy to reduce morbidity and mortality. A reliable blood loss detection method assists birth attendants to rapidly recognize excessive bleeding instead of waiting for changes in vital signs (blood pressure, pulse, and pallor). Earlier detection of excessive blood loss means that action can be taken sooner to provide medical management or transfer the woman to a higher level of care.

Various approaches for estimating excessive blood loss have been used in traditional birth attendant (TBA) training as well as for training obstetricians and nurse-midwives [5,42,43]. However, visual estimation of postpartum blood loss is notoriously unreliable [44–46]. Family members and unskilled birth attendants are estimated to perceive the signs of excessive bleeding during labor and postpartum only 11% of the time [47].

The BRASSS-V blood collection drape was developed to estimate postpartum blood loss for the previously mentioned misoprostol study in India [15]. The drape has a calibrated funneled collecting pouch attached to a plastic sheet that is placed under the buttocks of the woman after the delivery of her baby (Figure 2). A belt on the upper end of the sheet is loosely tied around the woman's abdomen to optimize blood loss collection, particularly for deliveries performed on the floors or pallets of homes or primary health posts. The plastic sheet also provides a clean surface for the woman, something which is not always otherwise available.

A clinical trial conducted at a District Hospital in Belgaum, Karnataka, India comparing the drape to visual estimation showed that visual estimates were 33% lower than the drape measurements. When the drape estimates were compared to mass spectrometry, the gold standard method for estimation of blood loss, the correlation was 0.93, indicating the drape's high level of accuracy. The drape is presently utilized in 13 countries, including several other research sites. It is simple, cost-effective ($1.50 per sterilized drape) and diagnoses excessive blood loss in a timely and accurate manner.

In Tanzania, the Kanga (a standard-sized, cotton cloth that is locally produced) is typically used to absorb blood during delivery. One study found that two Kangas would hold slightly more than 500 ml when completely soaked, providing a convenient unit of measure that could be used for determination of PPH [48]. The Kanga method could be adapted to other standardized cloths used in other countries (e.g. sari, dupatta, sarong) and/or to manufactured absorbent pads, where the clothes/pads could be saturated, weighed, and the volume of absorbed blood computed. However, their utility would always be somewhat dependent on the user's judgment of degree of saturation [42,49].

Other calibrated methods for collecting and measuring the volume of postpartum blood loss are not readily available or not easy to use in the home. For example: low-profile bed pans that are then emptied into a calibrated container; cholera beds with a plastic funneling sheet and calibrated collection bucket below and a collection bag that is then weighed have been used in hospital based studies of PPH, but do not translate well to non-clinical settings [50–52].

ANTI-SHOCK GARMENTS

Excessive uncontrolled bleeding due to PPH leads to hypovolemic shock, loss of consciousness and death due to multiple organ system failure (in rapid order) [53]. The ability to control blood loss and reverse shock at the community level and during transport to a higher level of care is crucial to reducing PPH related morbidity and mortality. Anti-shock garments (ASG) have been used by emergency medical personnel in the United States and other countries to stabilize people with lower body trauma [54].

One type of ASG, the non-pneumatic anti-shock garment (NASG) (Zoex Corporation, Ashland, OR, USA) is well-adapted for obstetrical hemorrhage in low resource settings (Figure 3) [55]. It is a simple, relatively inexpensive ($160 per garment), lightweight, reusable compression suit, comprising five neoprene segments that close tightly with Velcro around the legs, pelvis, and abdomen; the abdominal segment incorporates a small foam ball to supply increased pressure over the uterus. The entire garment, when tightly applied by one person, supplies 20–40 mmHg circumferential pressure. This lower body circumferential counter pressure shunts blood from the lower extremities and abdominal area to the essential core organs of heart, lungs and brain [12,41]. In addition to reversing shock, exerting circumferential pressure decreases both the transmural pressure and the radius of uterine and other lower body arteries to effectively reduce blood loss [54].

The NASG can be applied at the home or community level by family or community members with no medical training, at the primary health facility, or in tertiary hospitals during long delays in obtaining blood transfusions or surgery [56, 57]. The NASG has been tested in two quasi-experimental, hospital-based pilot studies in Nigeria and Egypt, and was an effective means for stabilizing women in shock while reducing blood loss and the associated sequeale of PPH [41,55,58,59]. These studies found the NASG to significantly reduce blood loss (50–64%) and time to recovery from shock, and to yield a 69%–72% non-significant decrease in morbidity and mortality [41,58,59].

Figure 3: Non-Pneumatic Anti-Shock Garment

Few other lower body circumferential anti-shock devices would be suitable to the home and community. A pneumatic anti-shock device (PASG or MAST, Medical/Military Anti-Shock Trouser), which has been used for lower body trauma and obstetric hemorrhage since the 1970s is more expensive ($550.00 per suit), more difficult to properly apply, and prone to over-inflation, which can cause necrosis and compartment syndrome in the compressed body parts [55,60–62]. Tightly wrapped compression stockings and locally designed tightly wrapped cloths also have been suggested; however, these have not been studied clinically (DA Bang, personal communication, 2007).

COMMUNICATION AND TRANSPORT SYSTEMS

Transfer to a higher-level facility is needed for definitive treatment such as blood replacement and surgery for intractable hemorrhage for women with excessive blood loss and shock who deliver at home or in a community-based facility. This requires a reliable local emergency communication and transport system to facilitate consultation with skilled attendants, transfer of the woman to a CEmOC facility, and to alert staff to the need for prompt care on arrival [21,63,64].

Emergency care needs to be planned and supported at national and local levels. Programs must be individually tailored to capitalize on available local resources. Although ambulances are an effective means for transport, they are expensive to purchase and staff and may have to serve a very large geographic area [65]. In some countries, local areas have been able to implement effective emergency transportation networks with support from local government or funding agencies [63,64]. Community loan funds have also been established in some areas to support transportation and care costs [66]. Transportation programs must also be specifically tailored to the culture and terrain in which they operate [63]. Because cultural factors—such as absence of the husband or other decision maker, refusal to give permission for transport, or financial difficulties—can be barriers to timely obstetric care during an emergency, the importance of culturally-sensitive, contextually tailored systems cannot be overstressed [67].

Only a few community-based, communication/transportation/referral pilot programs have been implemented and evaluated. In Bo, Sierra Leone, availability of a four-wheel drive vehicle and radio communication system resulted in an increase in obstetric cases transferred to the hospital and a reduction in mortality [65]. Community members in Sokoto, Nigeria, through negotiation with the local labor union, established agreements with commercial drivers to provide emergency transportation, and a fuel fund was established so that families could avoid delays in obtaining funds for transport [67]. Contact people within the community were recruited to facilitate referral, and training was also provided to drivers to sensitize them to the types of emergencies they would encounter [68]. In India, where availability of vehicles for personal use is limited, agreements have been made with drivers of service vehicles for emergency transport (BS Kodkany, personal communication, 2007). Community members in Nepal identified the need for stretchers to help transport women to health facilities, and women's groups helped to build or purchase them [69].

In some parts of Kenya, cell phones are widely used for emergency communication between birth attendants, transportation staff and the hospital, in some cases made possible by district support [63]. Implementation of an emergency radio network in health centers in rural Ouallam and Tahoua, Niger resulted in immediate increases in emergency calls, with a relatively low cost per call [70]. In many low resource settings, where few homes have landline-phones, the availability of a cellular signal in every village represents an easily-implemented mode of communication.

POSSIBLE STRATEGIES FOR IMPLEMENTATION

No one strategy fits all situations. The PPH continuum of care model must be tested and tailored to the specific social, cultural, geographic, political, and health systems contexts. In some settings the majority of births take place at home with TBAs or community health workers. In other areas, many women give birth at primary health care centers with the assistance of ANMs or more skilled attendants. The scenarios described below illustrate how the PPH strategy might function in two different settings. They are examples of many possible implementation scenarios. The various components will change depending on the available personnel, infrastructure and resources.

Traditional Birth Attendants at a Home Delivery

In this rural village, more than 2 hours from the nearest primary health care center, the majority of women

deliver with TBAs. These TBAs have received a 2 month training including hygienic delivery, problem recognition, and referral. They also have been trained to give 600 μg misoprostol orally when they cut the baby's umbilical cord and to massage the uterus after the placenta is out. In this locale, community mobilization activities have taken place. The community is aware of the dangers of too much bleeding and have worked together to create a revolving fund so that families in need of money for transportation and emergency obstetric care can borrow immediately from the fund whenever necessary. The community has an arrangement with the truck drivers who pass on the main road that when the drivers see a red flag during the day or a red light at night at a specific phone kiosk, it means a woman in the village has a complication.

When a woman delivers, the TBA and family members place a locally made cloth that holds 250 mL when saturated. They know that if a woman soaks two cloths following delivery that she is bleeding too much. If two cloths are soaked, a family member runs to village phone kiosk, has the phone operator place a call to the hospital to alert them that a woman with hemorrhage is coming, asks the operator to hang out the red flag or turn on the red light, and the family member picks up the NASG which is stored at the kiosk. The family member returns to where the TBA is massaging the woman's uterus and putting the baby to breast to help the uterus contract; however, the bleeding has not stopped. The TBA places the woman in the NASG, and takes her to the kiosk in a locally made stretcher. The woman can safely remain in the NASG in relatively stable condition for as long as 24 hours until a passing truck driver comes and picks her up for transport. The TBA accompanies the family and the woman to the referral facility where blood and definitive therapy are available [71,72].

Skilled Nurse/Midwife at Primary Health Centers

In this community there is one primary health center (PHC) for every 25,000 people. The skilled midwife is trained to provide prophylactic misoprostol, to perform all steps of AMTSL, and to give oxytocin for treatment of hemorrhage, as well as how to make referrals and use the NASG. In this facility they use the calibrated plastic drape, with a large black "TAKE ACTION" line at 500 mL. The community has provided a simple van to function as an ambulance, with a volunteer group of ambulance drivers

who provide coverage 24/7. If, despite the AMTSL with misoprostol and with intramuscular administration of oxytocin for bleeding over 500 mL, the woman continues to hemorrhage postpartum, an IV of saline is started by a skilled attendant, and the NASG, of which there are two in each PHC, is rapidly applied. The skilled attendant uses her cell phone (which was provided by the Ministry of Health) to call the referral hospital and to call the volunteer ambulance driver. The woman, a family member, and the skilled attendant are carried in the ambulance to the referral facility where blood and definitive therapy can be given.

DISCUSSION

No single intervention can prevent PPH-related morbidity and mortality. The current levels of PPH-related morbidity and mortality in low-resource settings are the result of the institutional, environmental, cultural, fiscal and social barriers to providing skilled care and to preventing, diagnosing and treating PPH. Although we support the goal of Safe Motherhood programs to provide all women with skilled attendance during delivery, to do that will take many years to train an additional 333,000 skilled attendants [73,74]. In the interim, to reduce morbidity and death, we must both reduce the number of cases of PPH and reduce its impact when it does occur by minimizing the time to diagnosis and treatment. We believe this can only occur through a multi-faceted PPH continuum of care approach that addresses all factors directly contributing to maternal death from hemorrhage. Use of a prophylactic uterotonic such as misoprostol, alone or as part of AMTSL can reduce the incidence of PPH. Use of a reliable blood loss estimation device, NASG or similar compression device, and community involvement in communication and transportation systems will hopefully address the many delays in hemorrhage recognition, stabilization and early management of women with shock and hemorrhage.

This PPH continuum of care model, if proven efficacious, can offer relatively low cost and low-technological solutions for reducing PPH and its associated morbidity and mortality. All of these proposed interventions have shown promise as single interventions, but have not yet been tested as a synergistic model of care. This approach needs region- and local- specific development and systematic testing before it is implemented. A study that incorporates all of these strategies, tailored to a specific

community, should be conducted in a high birth rate, high maternal mortality, and low resource setting. If effective, it could be translated into other contexts with appropriate modification for each setting.

Lastly, commitment and support from local communities, government entities, and policy makers from the outset is vital. At the community level, direct involvement will be necessary for acceptability of any intervention plans. Policy makers and governmental agencies will need to provide guidance and funding for sustainability. All of these groups can assure that interventions are sustainable, efficient, culturally appropriate, and answer to public health priorities. Most of the governments and ministries of health in developing countries are committed to reducing the high rates of maternal death. However, few have efficient and cost effective policies and plans for reducing maternal mortality [75]. Reaching the Millennium Development Goal (5) to reduce maternal mortality by 75% by the year 2015 will not be possible without political commitment and implementation of strategies that address PPH at the community and home level [76].

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