LITERATURE REVIEW
Innovations to address postpartum haemorrhage in low-income countries
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Introduction

Postpartum haemorrhage (PPH) is a common obstetric complication. The World Health Organization (WHO) defines postpartum haemorrhage as blood loss of 500 ml or more. The diagnosis is based on a clinical estimate of blood loss. WHO states that the loss of 500 ml of blood should be considered an alert, after which the health of the woman may be endangered. In many parts of the world, the loss of 500 ml of blood can be a serious threat to health due to the high prevalence of severe anaemia.

Approximately 30% (in some countries, over 50%) of direct maternal deaths worldwide are due to haemorrhage, mostly in the postpartum period. The Millennium Development Goal of reducing the maternal mortality ratio by 75% by 2015 will not be achieved unless the prevention and treatment of PPH in low-resource areas is prioritised.

Addressing PPH requires a combination of approaches to expand access to skilled care and, at the same time, extend life-saving interventions along a continuum of care from community to hospital. The different settings where women deliver along this continuum require different approaches to PPH prevention and treatment.

This study aims to review the current literature on innovations to prevent deaths related to postpartum haemorrhage in low-income countries. The review addresses two questions. What innovations are available to prevent deaths due to PPH? What is the evidence base for these interventions? The review aims to inform policies and programmes targeting the reduction of deaths due to PPH.

Method

Firstly, the databases MEDLINE, PUBMED and CINAHL were explored using several key-word combinations (and truncations): [‘postpartum hemorrhage’ or ‘postpartum haemorrhage’ or ‘PPH’ or ‘postpartum bleeding’] and [‘treat*’ or ‘interven*’ or ‘prevent*’] and [“innovation” or “advance” or “improve”]. As the literature review aims to identify innovations related to PPH, the period under review extends from 2000 to 2012, inclusive.

Secondly, several websites of the WHO, the International Federation of Gynecology and Obstetrics (FIGO) and the International Confederation of Midwives (ICM) were explored to find relevant publications on topic studied.

Thirdly, the bibliographies of all studies identified in the preceding steps were reviewed to further identify relevant articles.

Fourthly, studies were excluded describing innovations not relevant to low-income countries, such as the selective radiological embolisation of the bleeding vessel.

This search resulted in the identification of five non-surgical, non-pharmaceutical innovations related to PPH relevant for low-income settings:

- Lower uterine segment compression
- Non-pneumatic anti-shock garment
- Oxytocin administration into the umbilical vein
• Oxytocin in prefilled Uniject injection devices
• Hydrostatic intrauterine balloon tamponade

Finally the first three steps of the initial search were repeated, now using the key-word combination (and truncation): [“postpartum hemorrhage” or “postpartum heamorrhage” or “PPH” or “postpartum bleeding”] and [“Lower uterine segment compression”] or [“non pneumatic anti shock garment” or “NSAG”] or [oxytocin and “umbilical vein”] or [oxytocin and Uniject] or [“balloon tamponade” or “condom tamponade” or “foley catheter tamponade”]

**Results**

1. Lower uterine segment compression

Lower uterine segment compression (LUSC) is a technique that can be performed by pressing one hand abdominally onto the lower segment of the uterus (Figure 1 and 2). This method is easy to perform and does not require surgeons to place their hand into the vagina; therefore, patients feel no pain and anaesthesia is not necessary. It has no risk of genital tract infection and does not cost anything to perform.

The lower uterine segment contracts less than the body of the uterus because it has less muscle. In case of the low insertion of the placenta, even if patients have received uterotonics, haemorrhage can still occur because of the poor contraction of the lower uterine segment.

![Figure 1 Lower uterine compression method in treatment of acute postpartum haemorrhage by compressing at the lower uterine segment only.](image)
Figure 2 Lower uterine compression method in treatment of acute postpartum haemorrhage by compressing at the lower uterine segment with counteracting pressure from fundus.

Only two articles were identified describing the LUSC, both by the same author. In the first article the technique is described as an intervention to manage PPH and in the second as an intervention to prevent PPH.

Table 1 Findings from literature review: Lower uterine compression

<table>
<thead>
<tr>
<th>Setting</th>
<th>Study</th>
<th>Result</th>
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<tbody>
<tr>
<td>Department of Obstetrics and Gynaecology, at the Charoenkrung Pracharak Hospital in Bangkok, between January and August 2008</td>
<td>Randomised control trial - 66 cases of PPH were identified. Two patients were excluded from the present study due to cervical tear and extensive birth canal tear. Sixty-four patients met all inclusion criteria and were included in the present study. 32 patients were randomly assigned to the conventional protocol and the other 32 were managed by the conventional protocol with the addition of lower uterine compression. The lower uterine compression treatment was started promptly together with other modalities of PPH treatment.</td>
<td>The results of the study showed that lower uterine compression resulted in 105 ml or 47% reduction of blood loss compared to the conventional groups.</td>
</tr>
<tr>
<td>Department of Obstetrics and Gynecology, Charoenkrung Pracharak Hospital in Bangkok between July 2009 and March 2010</td>
<td>686 mothers with singleton pregnancy, gestational ages between 28 and 42 weeks enrolled in this study. All women had no past medical history and delivered by vaginal route. They were divided into two groups, the experimental group and the control group both receiving the same routine postpartum care. In the experimental group the subjects also received LUSC for 10 minutes.</td>
<td>Women in the experimental group who were additionally assisted by LUSC were found to have a lower incidence of PPH with statistical significance in comparison to those in the control group (2.9% vs. 6.8%; relative risk 0.43, 95% confidence interval 0.21-0.90, p = 0.02). The amount of blood-loss reduced by 29.26 ml.</td>
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</table>
Studies conducted assessing the effectiveness of the lower uterine compression method for the prevention and treatment of PPH suggest this method to be effective. It is simple to use, safe and involves no cost. Due to the study design, in particular the small sample size in both studies there is not a sufficient evidence base to rate this intervention. More research is needed before LUSC can be recommended to be included in the guidelines for the routine postpartum care.

2. Non-pneumatic anti-shock garment

The non-pneumatic anti-shock garment (NASG) is a first-aid compression garment device made of neoprene and hook-and-loop fastener. The NASG is applied to women experiencing hypovolemic shock secondary to obstetric haemorrhage, who can then be transported to a higher-level facility or, if already in such a facility, survive delays in obtaining blood and surgery.

It comprises lower-extremity segments, a pelvic segment, and an abdominal segment, which includes a foam compression ball that goes over the uterus\(^9\). The NASG reverses shock by compressing the lower-body vessels, shunting blood from lower extremities to the core organs, including the heart, lungs and brain. It also compresses the diameter of pelvic blood vessels, thus decreasing blood flow\(^10\). It is put on the woman, starting at the ankle and then rapidly closing the other segments until the abdominal segment is closed (Figure 3). This strategy enables woman can then be transported to a higher-level facility or, if already in such a facility, survive delays in obtaining blood and surgery.

The NASG is not a definitive treatment—the woman will still need to have the source of bleeding found and definitive therapy performed. The NASG can remain in place during any vaginal procedure and the abdominal segment can be opened for surgery. Removal of the NASG occurs only when the source of bleeding is treated, the woman has been haemodynamically stable for at least two hours, and blood loss is less than 50 mL/hour. Removal begins at the ankles and proceeds slowly, waiting 15 minutes between opening each segment, and taking vital signs (blood pressure and pulse) before opening the next segment\(^11\).

![Figure 3 Anti-shock garment fully closed.](image)

10 studies were identified that examined the effectiveness of the non-pneumatic anti-shock garment as part of the management of PPH\(^{10,12-20}\)
Table 2 Findings from literature review: Anti-shock garment

<table>
<thead>
<tr>
<th>Setting</th>
<th>Study</th>
<th>Result</th>
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<tr>
<td>Memorial Christian Hospital, Sialkot, Pakistan – June to July 2001&lt;sup&gt;13&lt;/sup&gt;</td>
<td>Case study of six women with obstetric haemorrhage who developed severe shock and were managed with the anti-shock garment.</td>
<td>Restoration of blood pressure occurred within five minutes in two patients who had no pulse and three who were unconscious or confused. All patients showed improvement of mean arterial pressure to greater than 70 mmHg within five minutes. None of the six women had significant further bleeding while the antishock garment was in place. Patients were comfortable during use of the anti-shock garment and no adverse effects were noted apart from a transient decrease in urine output.</td>
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<tr>
<td>Memorial Christian Hospital, Sialkot, Pakistan – August to November 2003&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Case study of fourteen women with obstetric haemorrhage who developed severe shock and managed with the anti-shock garment.</td>
<td>Thirteen patients survived without evidence of morbidity, but one had prolonged shock followed by multiple organ failure and death. This study confirmed that the NASG quickly restored the vital signs of most women in severe hemorrhagic shock and stabilised them while awaiting blood transfusion.</td>
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<td>Four tertiary care maternity facilities in Egypt – May to December 2004&lt;sup&gt;15&lt;/sup&gt;</td>
<td>All the women with haemorrhage meeting the eligibility criteria (158 women) were treated according to the standard protocol over a four month period; blood loss was measured and recorded. The NASG was then introduced, and all the women (206) meeting the eligibility criteria were treated according to the standard haemorrhage protocol plus the NASG for four months.</td>
<td>Median measured blood loss in the collection drape following study entry was 50% lower in those treated with the NASG (250 versus 500 mL, ( P &lt; 0.001 )). There was also a non-statistically significant decrease in morbidity and mortality.</td>
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<td>Four tertiary care maternity facilities in Egypt – May to December 2004&lt;sup&gt;12&lt;/sup&gt;</td>
<td>A secondary analysis of hospital data from a pre-post intervention study in Egypt (N=364 women with obstetric haemorrhage and shock), 158 received standard care, while 206 received standard care plus the NASG.</td>
<td>When the dose of oxytocin-received is statistically controlled the women in the NASG group had 303 mL less blood loss (299 mL) than women in the pre-intervention group (602 mL).</td>
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<td>Referral facility in Katsina, Nigeria, from November</td>
<td>Women were enrolled in a pre-intervention phase (n=83) and an intervention phase (n=86). All women</td>
<td>Mean measured blood loss in the intervention phase was 73.5 ± 93.9 mL, compared with 340.4 ±</td>
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<tr>
<td>Year</td>
<td>Condition</td>
<td>Intervention Details</td>
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<td>2006 to November 2007</td>
<td>had obstetric haemorrhage (≥750 mL) and a clinical sign of shock (systolic blood pressure 100 mm Hg or pulse N100 beats per minute).</td>
<td>248.2 mL pre-intervention. Maternal mortality was lower in the intervention phase than in the pre-intervention phase (7 [8.1%]) vs 21 [25.3%]) (RR 0.32; 95% CI, 0.14–0.72).</td>
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<td>Four tertiary care facilities in Nigeria from March 2004 - December 2007 and in two tertiary facilities in Egypt from June 2006 - May 2008</td>
<td>This study employed a pre-intervention/intervention design including 1442 women with ≥750 mL blood loss. Primary outcomes were measured mean and median blood loss, severe end-organ failure morbidity, mortality, and emergency hysterectomy.</td>
<td>Women in the NASG phase (n = 835) were in worse condition on study entry, 38.5% with mean arterial pressure &lt;60 mmHg vs. 29.9% in the pre-intervention phase (p = 0.001). Despite this, negative outcomes were significantly reduced in the NASG phase: mean measured blood loss decreased from 444 mL to 240 mL (p &lt; 0.001), maternal mortality decreased from 6.3% to 3.5% (RR 0.56, 95% CI 0.35-0.89), severe morbidities from 3.7% to 0.7% (RR 0.20, 95% CI 0.08-0.50), and emergency hysterectomy from 8.9% to 4.0% (RR 0.44, 0.23-0.86).</td>
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<tr>
<td>Four tertiary care facilities in Nigeria from March 2004 - December 2007 and in two tertiary facilities in Egypt from June 2006 - May 2008</td>
<td>Secondary sub-analysis of data collected in 2004 – 2008 including pre-intervention/NASG study data from 854 women.</td>
<td>Measured blood loss decreased by 50% between phases; women experienced 400 mL of median blood loss after study entry in the pre-intervention and 200 mL in the NASG phase (p &lt; 0.0001). As individual outcomes, mortality decreased from 9% pre-intervention to 3.1% in the NASG phase (RR 0.35, 95% CI 0.19-0.62); severe morbidity decreased from 4.2% to 1%, in the NASG phase (RR 0.24, 95% CI 0.09-0.67).</td>
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<tr>
<td>Four tertiary care facilities in Nigeria from March 2004 - December 2007 and in two tertiary facilities in Egypt from June 2006 - May 2008</td>
<td>Secondary sub-analysis of data collected in 2004 – 2008 only including pre-intervention/NASG study data of 288 women from the four referral facilities in Nigeria.</td>
<td>Mean measured blood loss decreased by 80% between phases. Women experienced 350 ml of median blood loss after study entry in the pre-intervention and 50 ml in the NASG phase (p &lt; 0.0001). Mortality decreased from 18% pre-intervention to 6% in the NASG phase (RR = 0.31, 95% CI 0.15–</td>
</tr>
<tr>
<td>Four tertiary care facilities in Nigeria from March 2004 - December 2007 and in two tertiary facilities in Egypt from June 2006 - May 2008 (^{20})</td>
<td>Secondary analysis of data collected in 2004 - 2008 from the pre-intervention/NASG study.</td>
<td>Twenty percent of women with ≥60 minutes between haemorrhage start and study admission experienced an extreme adverse outcome without the NASG compared with only 6% with the NASG.</td>
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<td>San Francisco General Hospital on the labour and delivery ward from June 2008 through January 2009 (^{10})</td>
<td>The resistive index (RI) of the internal iliac artery was measured in a sample of 10 postpartum volunteers with and without the NASG applied. Median RI was calculated and compared between baseline and full application.</td>
<td>Internal iliac artery median RI was 0.83 (SD 0.11) at baseline and increased to 1.05 (SD 0.15) with full NASG application (P = .02), thus showing that the NASG can reduce PPH.</td>
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In preliminary pre-intervention/ intervention trials in tertiary facilities in Egypt and Nigeria, the NASG was shown to significantly improve shock \(^9,^{12}\), decrease blood loss, reduce emergency hysterectomy for atony, and decrease maternal mortality and severe maternal morbidities associated with obstetric haemorrhage \(^{20}\). A definitive trial of the NASG for use prior to transport from lower-level facilities to tertiary facilities is currently underway in Zambia and Zimbabwe \(^{21}\). This trial will address the question of whether early application of the NASG at a satellite health facility level before transport to a referral hospital will decrease maternal mortality and morbidity. The available evidence indicates that the NASG substantially decreases blood loss, but there is no evidence that its application will reduce extreme adverse outcomes. It is also not known if possible side effects associated with NASG use might outweigh potential benefits. This study would rigorously test the effectiveness of the NASG using an experimental design with adequate power to detect statistically significant decreases in morbidity and mortality.

Even though many questions remain the NASG appears to have particular use in poor resource areas for various reasons. First, it is a simple technology that can be learned easily - while it is possible some people may not use it to its full effect, it is unlikely to cause harm \(^{11}\). Second, it is a low-maintenance device that does not take much shelf space, is easy to clean, and is reusable. Third, it is low cost. In many developing countries, especially in sub-Saharan Africa, where spending on maternal health is less than $2 per person, high cost interventions are impractical. The NASG is available at $55 per garment or <$1.50 per use \(^{22}\). Further, all healthcare staff can be easily trained in its use as no specialised knowledge is required to apply it \(^{11}\). Finally, the NASG is the only device available to stabilise women with shock until definitive treatments can be given. As hypovolemic patients may not have access to surgery and/or blood, the NASG can be useful for maintaining patients while they await definitive care \(^{11}\).

3. Oxytocin administration into the umbilical vein

The injection of an oxytocin solution into the umbilical cord after the cord is cut has been described as an innovation that may reduce PPH. A Cochrane review conducted in 2011 found that the injection of oxytocin into the umbilical vein "is an inexpensive and simple intervention that could be performed
while placental delivery is awaited. There was some evidence from the review of 15 trials, involving 1704 women, that an injection of oxytocin into the umbilical vein could reduce the need for manual removal of retained placenta after childbirth. However, high-quality randomised trials show that the use of oxytocin has little or no effect. Around half of the retained placentas will come out spontaneously if left; the optimal timing of manual removal is not known.\(^{23}\)

**Figure 4:** A nasogastric tube is threaded down the umbilical vein and 50IU Oxytocin is injected.\(^{24}\)

### 4. Oxytocin in prefilled Uniject injection devices

The Uniject injection device is an auto-disable, “all-in-one” injection system prefilled with the required dosage of drug—in this case, a single dose of oxytocin 10 IU (Figure 5). The injection-ready format reduces wastage, simplifies logistics, and allows use both by lay health personnel who do not normally administer injections and in areas with limited health infrastructure.\(^{25}\)

**Figure 5** Oxytocin in Unijet injection system

As oxytocin is known to be sensitive to temperature, Uniject has a time temperature indicator (Figure 6). This indicator provides a qualitative measure of cumulative heat exposure by changing colour to indicate when the injection system should no longer be used. Studies have shown that oxytocin loses 14% of its chemically active ingredient when stored at 30°C for one year.\(^{26}\) The time temperature indicator expands the use of oxytocin to the periphery by ensuring that even lay users are able to easily assess if a specific dose is still potent.
Four articles were identified to have examined the use of Oxytocin in prefilled Uniject injection devices. 27-30 and one article reports on a study of a protocol community-based cluster-randomized trial in Ghana where results are expected in mid 2013.31

Table 3 Oxytocin in prefilled Uniject injection devices

<table>
<thead>
<tr>
<th>Setting</th>
<th>Study</th>
<th>Result</th>
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<tr>
<td>This study was undertaken by the WHO/Indonesia, the Ministry of Health in Indonesia, and the Program for Appropriate Technology in Health (PATH). November 1999–February 2000 27</td>
<td>Pre- and post-intervention study that compared perceptions and self-reported practices of 140 village midwives related to the management of the third stage of labour. The intervention consisted of both training in active management of third-stage labour, including uterine fundal massage, controlled cord traction, prompt cutting of the cord, and injection of oxytocin, and supplying oxytocin in Uniject™. Midwives were trained to give a second dose of oxytocin if they thought a woman had PPH and to refer her if necessary. Midwives estimated the rates of PPH retrospectively from their registers for the one-year baseline period and tracked cases of PPH and use of oxytocin prospectively during the intervention period.</td>
<td>Injection practices and oxytocin availability did not change dramatically, although dose accuracy, use of sterile injection equipment, and proper disposal improved when the Uniject™ device was used. Midwives had little difficulty using the Uniject™ device properly; they overwhelmingly preferred it to standard needles and syringes. Postpartum haemorrhage rates did not change substantially. Oxytocin via Uniject™ holds promise for safer, more convenient use of oxytocin by trained midwives attending home deliveries, thereby potentially reducing the incidence of postpartum haemorrhage.</td>
</tr>
<tr>
<td>Maternity Hospital in Luanda, Angola, March 1998 and May 200028</td>
<td>A prospective study was performed comparing 782 women with physiological management with 814 women with active management of third stage of labour (AMTSL) using the Uniject™ device.</td>
<td>PPH was reduced from 40.4% to 8.2% and severe PPH (≥1000 ml) from 7.5% to 1% in the AMTSL group (P &lt; 0.001).</td>
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<tr>
<td>Three districts in northern Vietnam29.</td>
<td>Descriptive study using baseline and post-intervention questionnaires. The primary outcomes of interest were midwives’ perceptions of acceptability and ease of using the Uniject device. The study population consisted of 52</td>
<td>The majority of midwives reported that the Uniject™ device was easier to use and preferable compared with ampoules and standard syringes. They found the training materials easy to</td>
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</table>
Prophylactic oxytocin in the third stage of labour is a beneficial intervention with current low use, particularly in low and middle income countries. Innovations that would increase the use of oxytocin after delivery could have a huge impact on mortality rates. The studies identified in the literature review show that across multiple settings and cadres of health workers oxytocin in Uniject™ has been found to be well tolerated and easy to use and has a high level of acceptability among providers.

The main limitation of the findings is that none of the evidence derives from either randomised control trials or even a study with a control group. Such a design cannot exclude the possibility that socio-cultural trends or the effect of other simultaneous interventions could be alternative explanations of the findings. Furthermore, the small sample size means that chance cannot be excluded as a possible explanation.
However, the birth attendants' responses regarding the use of Uniject showed that they believed that the device facilitated the administration of prophylactic oxytocin and that if the device were not available oxytocin use could decrease.

5. Hydrostatic intrauterine balloon tamponade

FIGO describes this intervention as “a hydrostatic intrauterine balloon tamponade is a balloon usually made of synthetic rubber balloon catheters such as Foley catheters, Rush catheters, SOS Bakri catheters, Sengstaken-Blakemore and even using sterile rubber glove, condom, or other devices that is attached to a rubber urinary catheter and is then inserted into the uterus under aseptic conditions”6. This device is attached to a syringe and filled with sufficient saline solution, usually 300 mL to 500 mL, to exert enough counter-pressure to stop bleeding. When the bleeding stops, the care provider folds and ties the outer end of the catheter to maintain pressure. The balloon can be left in place for up to 24 hours; it is gradually deflated over two hours, and then removed. If bleeding starts again during the deflating period, the balloon tamponade can be re-inflated. A balloon tamponade may arrest or stop bleeding in 77.5% to 88.8% or more cases without any further need for surgical treatment6. Other reviews state that the balloon tamponade is effective in 91.5% of cases and recommend that this relatively simple technology be part of existing protocols in the management of PPH32. Further, the balloon tamponade can test if the bleeding is uterine or from another source. If the bleeding does not stop with inflation, it is likely to be coming from a laceration or cause other than uterine atony.

Figure 7 A condom is tied on Foley’s catheter with a silk thread 33.
Figure 8 The condom (inserted in the uterine cavity) is inflated with saline retrograde through the Foley’s catheter to control bleeding 33.

Figure 9 Hydrostatic intrauterine balloon using a glove6.

Figure 10 Hydrostatic intrauterine balloon tamponade using the Bakri SOS balloon6.

Ten articles were identified reporting on the use of different balloon tamponades either after vaginal delivery or during caesarean section 33-42.

Table 4 Findings of literature review: Hydrostatic intrauterine balloon tamponade

<table>
<thead>
<tr>
<th>Setting</th>
<th>Study</th>
<th>Result</th>
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<tbody>
<tr>
<td>Obstetrics and Gynecology</td>
<td>Prospective study with 152 cases of PPH - 109 were managed medically; 20 were managed using the B-Lynch procedure, and 23 were managed using the condom catheter.</td>
<td>In all 23 cases in which the condom catheter was used, bleeding stopped within 15 minutes. No patient needed further intervention. No patient went into</td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
<td>Findings</td>
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<tr>
<td>Hospital, Bangladesh, between July 2001 and December 2002&lt;sup&gt;34&lt;/sup&gt;</td>
<td>Two case studies of the control of postpartum haemorrhage with a intrauterine Foley catheter after vaginal deliveries.</td>
<td>Both cases report the successful use of an intrauterine balloon tamponade with immediate arrest of bleeding.</td>
</tr>
<tr>
<td>Tertiary care facility in Nigeria 2002&lt;sup&gt;35&lt;/sup&gt;</td>
<td>Cross-sectional study of women with primary postpartum haemorrhage and blood loss &gt;1000ml were included in the study. Medical record files of these women were reviewed for maternal mortality and morbidities which included mode of delivery, possible cause of postpartum haemorrhage, supportive, medical and surgical interventions.</td>
<td>In two cases Foley catheter balloon tamponades were used successfully after vaginal deliveries. In one case the pyrexia was reported in the postpartum period.</td>
</tr>
<tr>
<td>Department of Obstetrics and Gynaecology at Aga Khan University Hospital, Karachi between January 1, 2003 and July 31, 2004&lt;sup&gt;36&lt;/sup&gt;</td>
<td>Case study of management of postpartum haemorrhage with condom catheter tamponade in two women with impaired coagulation.</td>
<td>In both cases condom catheter tamponades were used successfully in women with coagulopathy and HELLP syndrome after vaginal deliveries.</td>
</tr>
<tr>
<td>Department of Obstetrics and Gynaecology, Postgraduate Institute of Medical Education and Research, Chandigarh, India&lt;sup&gt;37&lt;/sup&gt;</td>
<td>Four case studies of PPH due to uterine atony in which intrauterine tamponade with an inflated condom was used.</td>
<td>In three cases the haemorrhage was successfully arrested. In one case the women died due to disseminated intravascular coagulation.</td>
</tr>
<tr>
<td>Department of Obstetrics and Gynaecology, Usman Danfodiyo University Teaching Hospital, Sokoto, Nigeria&lt;sup&gt;38&lt;/sup&gt;</td>
<td>This prospective, observational study examined 53 patients who developed massive PPH and were not controlled by usual measures. Condom tamponades were used in all cases.</td>
<td>Out of 53 cases, PPH was controlled in 52 cases. One patient died as the patient was eclamptic and developed disseminated intravascular coagulation. No patient required surgical intervention.</td>
</tr>
<tr>
<td>Rajshahi Medical College Hospital, Bangladesh, August 2007 to September 2008&lt;sup&gt;39&lt;/sup&gt;</td>
<td>Prospective observational study in which Foley’s catheter condom tamponade was applied in fourteen cases of women with PPH.</td>
<td>The condom tamponade stopped bleeding in all the cases. Average amount of blood loss was 1221 ml. No complications were noted.</td>
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</table>
A considerable number of articles report on the effectiveness of balloon tamponades in low-resource settings. Unfortunately no randomised controlled studies of hydrostatic intrauterine balloon tamponade have been conducted leaving doubt on the effectiveness of these devices. Additionally, there is no way to be certain whether a woman who had a uterine balloon placed would have had a different outcome had the balloon not been placed. It is well known that some women will surprisingly survive even if haemorrhage is massive.

The reports so far suggest that balloon tamponade is helpful in managing PPH secondary to a wide variety of causes in resource-poor settings, including uterine atony, coagulopathy, retained placenta, placenta praevia and placenta accrete. Though in this review the indications and techniques for insertion and removal of the balloon tamponade as well as absence or presence of the use of routine therapies varied, the effectiveness of balloon tamponade was evident. For example, specifically, differences arose in how to assemble and inflate the condom catheter as well as more generally when to give routine uterotonics or prophylactic antibiotics.

Complication rates were low in the use of all types of balloon tamponade, with no reported cases of uterine rupture and no increased risk of infection. These facts, combined with low cost and ready availability, make balloon tamponade, especially the condom catheter, an ideal addition to the PPH protocol in the low-resource setting.

Carefully designed research studies may help to define a best-evidence uterine balloon device and placement protocol, including the optimal fluid infusion amounts for balloon efficacy, the role of routine uterotonics, antibiotics, vaginal packing and cervical closure, and optimal timing for balloon removal.
Despite the many open questions, current research does suggest that the balloon tamponade is effective and FIGO recommends that it should become well integrated in the treatment of PPH at all levels of the health system.

**Discussion**

Women in developing countries face a high risk of dying from PPH. Often these deaths are related to the poor health services provided to women in these countries and innovations to improve patient care seem indispensable. The innovations discussed in this paper may therefore contribute to better health outcomes. LUSC may reduce massive haemorrhage related to the low insertion of the placenta. The NSAG may be used as a first aid device to improve shock and decrease blood loss, thereby reducing the need for hysterectomies and decrease maternal mortality. Oxytocin in prefilled Uniject injection devices may ensure a higher use of oxytocin after delivery, known to reduce the incidence of PPH. And the hydrostatic intrauterine balloon tamponade may successfully arrest bleeding due to an atonic uterus.

These innovations are however only a small part of the comprehensive guidelines addressing the prevention and management of PPH and management of shock (Figure 11). And even the most sophisticated PPH guidelines can only prevent maternal deaths if they are delivered within a functional health system. The challenge is to construct and sustain a functional health system in resource-poor settings, where socio-cultural and economic factors are major barriers to accessing obstetric care. Health systems are needed in which skilled birth attendance work in an enabling environment, with access to essential drugs and supplies, communication system, a functional referral network and the necessary training to maintain and/or improve their skills.

<table>
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<tr>
<th><strong>Health System</strong></th>
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<tr>
<td><strong>Prevention</strong></td>
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<td>Iron supplementation during pregnancy</td>
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<td>Birth preparedness</td>
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<td>Identification of high-risk women</td>
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<td>Use of Partogramme</td>
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<td>Active management of third stage of labour with Uniject device</td>
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<td><strong>Lower uterine segment compression (LUSC)</strong></td>
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<td><strong>BLEEDING</strong></td>
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<td>Give Oxytocin</td>
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<td>Uterine massage or LUSC</td>
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<tr>
<td>Empty bladder</td>
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<td>Address cause of bleeding</td>
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<td><strong>Management of PPH</strong></td>
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<td><strong>Management of Shock</strong></td>
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<td>Give fluids</td>
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<td>Apply aortic compression</td>
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<td>Anti-shock garment</td>
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The provision of effective care for women with haemorrhage is often beyond the capacities of health systems and communities in countries where maternal mortality is high. To reduce maternal deaths due to PPH, and to make pregnancy and motherhood in general safer for all women, communities, governments, NGOs, healthcare providers, and civil society can support actions that include:

- Increase political will and strengthen leadership to support the improvement of maternal health.
- Address the socio-economic and cultural barriers that prevent women from accessing necessary health care during pregnancy, childbirth and postpartum.
- Raise community awareness of poor maternal health, increase recognition of danger signs and improve birth preparedness.
- Ensure that a skilled health provider with midwifery skills attend every birth: policies need to support the training, deployment and ongoing professional support of skilled personnel, especially in rural and underserved areas.
- Upgrade health facilities to ensure adequate transportation and communication structures, as well as the necessary supplies, drugs and equipment.

References