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FEBRASGO POSITION STATEMENT

Postpartum hemorrhage: prevention, diagnosis and non-surgical management

2024 Special Edition

The National Specialized Commission for Obstetric Emergencies of the Brazilian Federation of Gynecology and Obstetrics Associations (Febrasgo) endorses this document. Content production is based on scientific evidence on the proposed topic and the results presented contribute to clinical practice.

Key points

- Postpartum hemorrhage is the world's leading cause of maternal death and peripartum hysterectomy.
- The main causes of postpartum hemorrhage are uterine atony, birth canal trauma, retention of ovular remains and coagulation disorders.
- Risk stratification for postpartum hemorrhage optimizes care planning and promotes the early adoption of preventive and therapeutic measures.
- Early control of the bleeding focus is the most efficient measure in the treatment of postpartum hemorrhage, hence the importance of the golden hour in obstetric care.
- The shock index is the clinical method of choice for estimating blood loss and is also useful in predicting blood transfusion.
- The medications used in pharmacological therapy for postpartum hemorrhage are uterotonics in cases of atony, and tranexamic acid, which must be used in all cases, regardless of the etiology of the hemorrhage.
- In view of the failure of pharmacological therapy in uterine atony occurring after vaginal deliveries, the intrauterine balloon tamponade and/or the vacuum aspiration system should precede the surgical approach.
- When available, the non-pneumatic anti-shock garment is useful in the temporary control of postpartum hemorrhage, especially in patients with hemodynamic instability, enabling continuity of treatment and patient transfers.

Recommendations

- Every pregnant woman with a previous cesarean section should have an ultrasound scan to determine the placental location. In case of placenta previa or implanted in the uterine segment, investigation of ultrasound signs of placenta accreta and referral to a reference service for continuity of care are indicated. Faced with the suspicion of parametrial invasion and in later cases of placenta previa, nuclear magnetic resonance or three-dimensional ultrasound may contribute to the investigation. The delivery of these pregnant women must take place in a tertiary service.
- The main preventive measure for postpartum hemorrhage is the intramuscular administration of 10 units of oxytocin immediately after birth, associated with active management of the third stage carried out by a trained professional. Oxytocin requires refrigeration to guarantee its quality. In places where oxytocin is unavailable or its quality is not guaranteed, the use of other uterotonics for prophylaxis such as carbetocin, methylergometrine (exclude in hypertension) or misoprostol is recommended. The routine use of tranexamic acid for prophylaxis of hemorrhage after vaginal births or cesarean sections is not recommended.
- Uterine tone monitoring (gentle massage) after childbirth is recommended as a strategy for early identification of uterine atony.
- Upon diagnosis of postpartum hemorrhage, treatment must be started immediately. The sequencing of care should include requesting help, performing a uterine compression maneuver, rapid assessment of etiology, maintaining oxygenation and tissue perfusion, obtaining large venous accesses with blood sample collection and request for laboratory tests, blood volume replacement, administration of tranexamic acid and uterotonics, evaluation of antibiotic prophylaxis and blood loss estimation.
- Blood loss can be estimated by visual assessment, weighing of surgical compresses, use of collecting devices or by clinical methods.
- Intravenous oxytocin is the first-line uterotonic in the treatment of uterine atony. Tranexamic acid at an intravenous dose of 1 gram in a 10-minute infusion should be administered immediately after diagnosis, regardless of the hemorrhagic etiology. Additional intravenous doses of 1 gram should be administered if bleeding persists after 30 minutes or if bleeding recurs within 24 hours from the first dose.

- Volume resuscitation with crystalloids should not exceed 2,000 mL and transfusion of blood components is usually indicated in hypovolemic shock, especially if moderate or severe. Hemodynamically unstable patients with significant blood loss are candidates for receiving an emergency transfusion of two packed red blood cells. If crossmatch testing is not available, O negative blood should be transfused.
- The intrauterine balloon tamponade can be employed after vaginal delivery and during or after cesarean section with specific volumes of infusion. Depending on the tamponade test, balloons with drainage function should be preferred. Uterotonics and antibiotics should be administered during the entire tamponade time. The balloon should be removed after hemodynamic stability, preferably before 12 hours, with operating room scheduling.
- Intrauterine vacuum-induced hemorrhage control devices are also recommended for the non-surgical invasive treatment of postpartum hemorrhage unresponsive to pharmacological treatment. In addition to the high success rate in hemorrhagic control in both modes of delivery, they offer the advantage of reducing the time between insertion and removal of the device.
- The non-pneumatic anti-shock garment does not replace therapeutic actions and must be linked to a postpartum hemorrhage care protocol.

Background

Postpartum hemorrhage (PPH) is defined as the cumulative blood loss of 1,000 mL or more, accompanied by signs or symptoms of hypovolemia within 24 hours after birth, regardless of the mode of delivery. Blood loss greater than 500 mL after vaginal births can also be considered abnormal, especially in more vulnerable populations.[1] The incidence of PPH is variable and estimated at 1%-10% of births. Currently, this is the leading cause of maternal death worldwide, with about 80,000 deaths annually,[2] most of which are considered preventable and occur in low- and middle-income countries.[3]

In addition to high mortality, a significant number of patients who survive severe PPH evolve with physical and/or emotional sequelae.[4] Therefore, it is essential that all institutions and professionals providing childbirth care are properly prepared to prevent, diagnose and treat a condition of PPH.

What is the golden hour in PPH?

Early control of the bleeding site is the most effective strategy for preventing hypovolemic shock. The term "golden hour in obstetrics" has been introduced in this context, referring to a strategy for controlling the hemorrhagic site within the first hour after its diagnosis.[5,6] Note that massive bleeding may require an even earlier control in order to avoid serious maternal complications. Through an early, aggressive, efficient, organized approach without delay, the deadly triad of hemorrhagic shock (hypothermia, acidosis and coagulopathy) can be avoided.[6] To this end, it is essential that the golden hour is linked to an adequate and systematized PPH response control.

What are the characteristics of an Early Warning System (EWS) in Obstetrics for PPH?

The obstetric safety bundle is an orderly work system aimed at organizing and coordinating actions to reduce the risk and morbidity and mortality of PPH.[7,8]

The EWS in obstetrics proposes the implementation of work processes that include risk stratification of PPH, routine and universal use of uterotonics after births, timely diagnosis of cases and continuous monitoring of patients. It is essential to organize care flows with well-defined massive management and transfusion protocols, and availability of PPH kits accessible to the entire care team in order to ensure a safe and effective service. The EWS in obstetrics promotes the involvement and training of multidisciplinary and intersectoral teams and encourages the implementation of a communication and learning system, thereby helping to develop constructive leadership skills and allowing continuous monitoring of risk situations. It also contributes to the organization of the health network with the aim to guarantee care flows and access to more complex treatments and enable care transfers.[9]

What are the preventive measures in PPH?

The magnitude of PPH morbidity and mortality reveals the importance of its prevention and the identification of risk factors. Anemia and hypertensive syndromes stand out among its various risk factors. Risk stratification is a useful strategy for reducing maternal death from PPH. High-risk factors are: placenta previa or low-lying placenta, preeclampsia with signs of severity, hematocrit <30%, platelets <100,000/mm^3, active bleeding upon admission, coagulopathies, use of anticoagulants, placental abruption and placenta accreta.[1,6]

The main preventive measures for PPH are the administration of oxytocin and the active management of the third stage of labor. The most recommended prophylactic oxytocin regimen is the intramuscular administration of 10 units of oxytocin immediately after birth. In the case of cesarean section, an alternative is intravenous prophylaxis by the "rule of three", in which three units of oxytocin are slowly (≥30 seconds) infused and can be repeated at three-minute intervals until the third dose. This scheme involves maintenance intravenous infusion (15 units in 500 mL of 0.9% saline at 100 mL/hour).

When oxytocin is not effective in obtaining uterine contraction, methylergometrine or misoprostol should be administered in sequence, as long as there are no contraindications. Note that oxytocin requires refrigeration and protection from light to guarantee the quality of its pharmacological properties.[1,6]

Oxytocin has been recommended as the first-line medication for preventing PPH. However, the use of other uterotonics, such as carbetocin, ergot derivatives and misoprostol, is indicated in special situations, mainly when oxytocin is unavailable for prevention, or its quality cannot be guaranteed due to storage-related problems. Carbetocin is a long-acting, synthetic analogue of oxytocin that can be used intramuscularly or intravenously at a dose of 100 µg (1 ampoule) after childbirth when the cost of its use is comparable to the costs of prevention with available uterotonics. It is an effective uterotonic with the advantages of being thermostable, having a longer-lasting uterotonic effect and a safety profile similar to that of oxytocin. Carbetocin is not indicated for the treatment of PPH and the main limitation is its cost. The use of ergot derivatives may also be considered in these situations. The use of methylergometrine is recommended intramuscularly at a dose of 0.2 mg (1 ampoule) as long as there are no contraindications, among which hypertension stands out. The combined use of methylergometrine with oxytocin is also possible with the intention of reducing bleeding greater than 500 mL. Contraindication situations and the possibility of increased side effects require caution. Misoprostol is a synthetic analogue of prostaglandin E1 that may also be used to prevent PPH. Its isolated use is only foreseen in scenarios where there is a lack of oxytocin or its refrigeration cannot be guaranteed. The recommended dose is 600 to 800 µg rectally, as the oral formulation is not yet available in the country. It can also be used in combination with oxytocin with the aim of reducing bleeding greater than 500 mL, although also with caution given the increase in side effects.[9-11]

Regarding the role of tranexamic acid in preventing PPH, its benefit in reducing blood loss and blood transfusions has motivated reviews, meta-analyses and randomized clinical trials. Its benefit in reducing blood loss, the need for blood transfusion and additional uterotonics, as well as the incidence of PPH after vaginal births was proven by a meta-analysis of 17 randomized clinical trials with low risk of bias including 7,122 patients.[12] In cesarean sections, the reduction in the incidence of PPH and blood transfusion in postpartum women who received prophylactic uterotonics was demonstrated by a multicenter randomized clinical trial including 4,551 patients.[13] However, in a more recent multicenter randomized clinical trial involving 31 hospital units and 11,000 parturient women, benefits from tranexamic acid in reducing blood transfusions or deaths from PPH in cesarean sections have not been found.[14] Therefore, despite the favorable results of some robust studies and favorable perspectives, limitations of evidence regarding the benefit of tranexamic acid in preventing PPH remain, as well as the recommendation of its use only in treatment.[9]

Active management of the third stage includes timely clamping (between one and three minutes) and controlled umbilical cord traction (Brandt-Andrews maneuver). Although skin-to-skin contact (for two hours or more) and uterine monitoring/massage in the first two hours after discharge do not reduce the rate of PPH, these are recommended as strategies for surveillance and early diagnosis of PPH and optimization of the experience with childbirth. Other preventive measures for PPH include the rational use of oxytocin in labor, the selective use of episiotomy and the specific recommendation against the use of the Kristeller maneuver.[1,6]

How should the PPH diagnosis and the blood loss estimate be?

The most current definition establishes cumulative 1,000 mL as a diagnostic criterion for PPH, regardless of the mode of delivery.[1] However, especially if accompanied by risk factors, blood losses greater than 500 mL after vaginal deliveries may be considered abnormal. Losses above 1,000 mL can be classified as severe PPH and those greater than 2,000 mL as massive hemorrhage, usually accompanied by a hemoglobin drop ≥ 4 g/dL, coagulopathy and the need for massive transfusion.[10] Decreases in hematimetric indices (hemoglobin, hematocrit) are late and do not immediately reflect blood loss. As these are representative of blood loss only about four hours after the onset of hemorrhage, they are of limited use in the management of acute and severe PPH.[11] In addition, gestational hypervolemia delays the onset of the first signs of hypovolemic shock, especially among healthy pregnant women. In these, hemodynamic changes occur only after losses greater than 20%-30% of blood volume (1,500 to 2,000 mL). In view of the clinical evidence of blood loss above the usual, there must not be delays in the institution of treatment.[6]

Strategies for diagnosing and estimating volume loss are varied and include visual estimates, weighing of pads, collecting devices and clinical parameters, among which the shock index (SI) stands out. Although the visual estimate of blood loss is simple and quick, it is subjective and underestimates voluminous losses by up to 2-3 times.[12] Figure 1 shows some visual parameters for quantifying the bleeding present in surgical packs, sheets and puddles.

Weighing of pads, surgical drapes, sheets and other supplies used in childbirth care is useful, especially in PPH linked to cesareans and hysterectomies. However, it requires systematization of care, knowledge and standardization of the size and weight of the inputs. The blood loss in mL is obtained by using the equivalent of 1 mL of blood and 1 g of weight, calculating the difference between the weight of the blood-containing supplies and their dry weight.[6,21]

The estimate with use of collecting devices positioned below the buttocks just after vaginal delivery is useful and more reliable than other strategies for estimating blood loss.

Puddle of 100 cm in diameter	Bed with puddle on sheet	Vaginal bleeding with blood flowing to the floor

Dressings

50% = 25 mL	75% = 50 mL	100% = 75 mL	Dripping compress = 100 mL

Puddle 50 cm in diameter	500 mL
Puddle 75 cm in diameter	1,000 mL
Puddle of 100 cm in diameter	1,500 mL
Bed with puddle of blood on the sheet -	Probably less than 1000 mL
Vaginal bleeding with blood flowing to the floor	Probably exceeds 1000 mL

Source: Adapted from Bose et al. (2006)[18] and Dildy et al. (2004).[19]

Figure 1. Visual parameters for quantifying the bleeding in surgical dressings, sheets and puddles

However, it is also prone to failures, as it can be interfered with by the inclusion of amniotic fluid and urine eliminated simultaneously.[6,21]

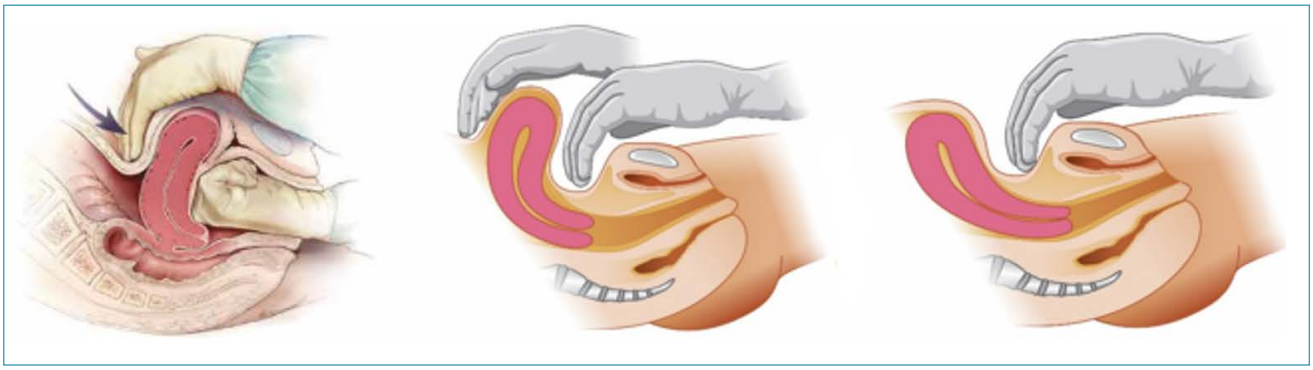
Although clinical parameters (blood pressure, heart rate - HR) are later diagnostic markers, they are very useful for determining the severity of shock, evaluating the therapy instituted and indicating additional therapies. The SI is an adjunct in the estimation of volume loss and an earlier marker of hemodynamic instability, with values that correlate with the need for blood transfusion and care transfer. Its calculation is made by dividing HR by systolic blood pressure (SBP). Shock index values ≥ 0.9 indicate significant blood loss and ≥ 1 (HR higher than SBP) signal the need for a fast approach and the possibility of blood transfusion in patients with PPH. The SI increases as the maternal hemodynamic state worsens. Values between 1.3 and 1.7 (moderate shock) and > 1.7 (severe shock) are proposed as indicators for assessment of the immediate need for massive transfusion.[22, 23] Changing the SI cutoff point from ≥ 0.9 for ≥ 1 is also proposed with the aim to facilitate its use in clinical practice.[24]

What should be the initial therapeutic measures in the PPH approach?

When PPH is diagnosed, the entire care team must know the steps of treatment according to the causes and be able to institute them. Defining the hemorrhagic etiology and estimating the severity of the condition are essential steps in care. The main causes of PPH are uterine atony, genital tract lacerations, placental disorders and coagulopathy (the four Ts: tone, trauma, tissue and thrombin), each requiring a specific approach.[1,6]

Regardless of the cause, it is important that the entire team is familiar with the initial measures of care. The first step is to clearly communicate the diagnosis and organize the multidisciplinary team. The hemorrhage kit must be requested and one of the team members must be assigned for the communication and guidance of the patient and companions. Auxiliary professionals must know their roles and perform them simultaneously. A member should lead the team and ensure that actions are taken. In order to reduce bleeding, bimanual uterine compression is initiated by means of Hamilton maneuver (anesthetized patients or those with greater tolerability) or Chantrapitak maneuver (Figure 2) maintained during the subsequent processes.[1,6,19,25]

An assistant must be responsible for the continuous monitoring of the patient to calculate the SI. Two other assistants provide two large venous accesses (jelco 14 or 16), which will provide the infusion of crystalloids and medications and the collection of blood samples. Complementary tests should include blood typing (if unavailable), cross-



Source: Adapted from Anderson and Etches. Prevention and management of postpartum hemorrhage. Am Fam Physician. 2007;75(6):876-81.[20] Illustrations by Felipe Lage Starling (authorized).
Left: Hamilton maneuver. Center: Chantrapitak maneuver for patients with relaxed abdominal wall. Right: Chantrapitak maneuver for patients with a tight abdominal wall.

Figure 2. Hamilton and Chantrapitak uterine compression maneuvers.

match testing, complete blood count, coagulogram, fibrinogen, ionogram test, clot test (Wiener) and, in severe cases, lactate and blood gas analysis. Oxygenation with a face mask (100% O_2; flow of 8 to 10 liters per minute) should be instituted. Indwelling bladder catheterization, elevation of the lower limbs, warming up of the puerperal woman, assessment of antibiotic prophylaxis, estimation of blood loss and rapid assessment of the etiology (revision of the birth canal) with location of hemorrhagic foci should be provided quickly. Subsequent hemostatic measures to define treatment should be instituted according to the etiology. When available, a non-pneumatic anti-shock garment (NASG) can be included in these initial measures. Subsequently, volume loss and hemodynamic repercussion are reassessed, with the intention of defining the need for blood transfusion. In the PPH scenario, the limitation of healthcare professionals requires efforts for the correct sequence of care, reinforcing the need for kits and checklists, which, when used by trained professionals, are also essential to ensure the adequate treatment.[6] Figure 3 systematizes the initial clinical management of PPH.

How should the pharmacological management of PPH be?

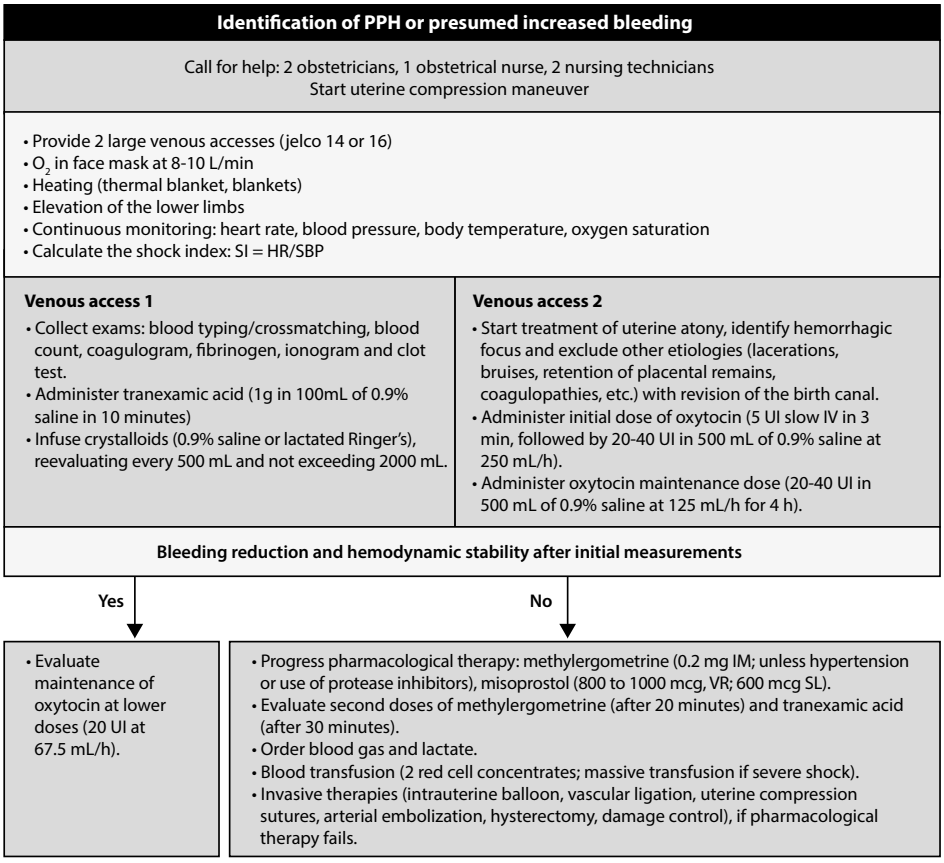
Oxytocin and tranexamic acid should be the first drugs infused in patients with PPH. Tranexamic acid should be administered intravenously as early as possible at a dose of 1 gram diluted in 100 mL of 0.9% saline within 10 minutes. Administration of this first dose three hours after the onset of PPH appears to be of no benefit. A second dose (1 gram) should be administered after 30 minutes if bleeding control has not been achieved. If bleeding recurs within 24 hours of initial administration, another dose of 1 gram can be infused. The uterotonic infusion regimens are variable and designed for the treatment of uterine atony. The initial slow infusion (three minutes) of five units of oxytocin is suggested, followed by 20 to 40 units in 500 ml of saline administered at 250 ml/hour. A sequential maintenance schedule should be administered at 125 mL/h for four hours. In the most severe cases of uterine atony, maintenance of oxytocin for up to 24 hours (67.5 mL/h or 3 units/h) should be considered with monitoring for water intoxication.[1,6,27]

In view of an inadequate response to oxytocin, sequential infusion of other uterotonics is necessary and the time interval for decision making should not exceed 15 minutes, since these are fast-acting drugs. In the absence of arterial hypertension or the use of protease inhibitors, methylergometrine (0.2 mg intramuscular) should be the second uterotonic administered and may be repeated after 20 minutes. The third-line uterotonic is prostaglandin. Rectal administration of 800 to 1,000 mcg of misoprostol is suggested, as it is the only formulation available in the country.[1,6]

In parallel with the use of uterotonics, it is necessary to maintain uterine compression (while waiting for the drug to take effect) and perform a clot test and revision of the birth canal with the aim to exclude other etiologies (genital tract lacerations, uterine rupture or inversion, retention of ovular remains, coagulopathies). These etiologies require specific treatments, such as uterine curettage (ovular remains), sutures (genital tract lacerations), uterine repositioning maneuver (uterine inversion), laparotomy for repair or hysterectomy (uterine rupture) and transfusion of blood components (coagulopathies). Paying attention to the association of etiologies is essential in determining hemorrhage and its persistence.[1,6] Figure 3 shows the initial drug management of PPH.

When and how to use an intrauterine balloon tamponade?

The main indication for an intrauterine balloon tamponade (UBT) is the failure of pharmacological therapy in uterine atony. It is also indicated for the treatment of hemorrhage occurring after removal of ovular material, although its success rate is slightly lower than that of uterine atony. In milder situations on the spectrum of placenta accreta, absent deep myometrial involvement and thinning of the uterine wall, its careful use with minimal infusions is also indicated. As the achievement of transient hemostasis is also an objective of the uterine tamponade, a balloon can be temporarily used in patients who will be transported to



Source: Adapted from the Pan American Health Organization (2018).[6]

Figure 3. Sequencing of the initial clinical management of postpartum hemorrhage

referral units or those with coagulopathy who need specific therapies, providing damage control. The bleeding control mechanism of UBTs occurs through the elevation of hydrostatic pressure against the uterine wall, promoting an increase in myometrial capillary pressure and a reduction in blood flow in the uterine arteries, as evidenced by Doppler flowmetry. It also appears to promote mechanical stimulation of uterine contractions.[28]. The main contraindications to the use of UBT are pregnancy, infections in the internal genitalia, abnormalities distorting the uterine cavity, uterine rupture, allergy to balloon components and arterial bleeding requiring surgical treatment or embolization. The UBT can be manufactured (Bakri, BT-Cath, Ebb, Zhukovskiy, Ellavi, Pergo, Kyoto) or, if these are unavailable, handcrafted (Shivkar, Baskett, El Menia, El Hennawy, Alves) (Figure 4).[6,29-30]

The UBT may or may not have a blood drainage function. The preparation for its postpartum vaginal insertion includes, in sequence, antisepsis (vulvar, vaginal and cervical), indwelling urinary catheterization and exposure of the vagina and cervix through vaginal valves. After clamping and tractioning the anterior lip of the cervix, the intrauterine balloon insertion can be performed manually or by means of Foerster forceps, and guidance of pelvic ultrasound is recommended. Before infusion, the balloon should be fixed, preferably with vaginal compress-

Source: photographic records of the authors; illustration by Felipe Lage Starling (authorized).
Handcrafted: 1 – Shivkar; 2 – Baskett; 3 – El Hennawy; 4 – Alves; Manufactured: 5 – Bakri; 6 – BT-Cath; 7 – Ebb; 8 – Ellavi; 9 – Zhukovskiy; 10 – Pergo; 11 – Kyoto.

Figure 4. Intrauterine balloons.

es. Alternatively, fixation can be performed by cervix suture or by apprehending the edges of the cervix with vascular clips or forceps. After fixation, the balloon is infused with heated saline solution using syringes or equipment. After vaginal delivery, the recommended infusion is between 350 and 500 mL. If a drainage system is available,

its permeability must be checked (light infusion to ensure clearance) and connected to a collection bag. Antibiotic prophylaxis (cephalosporin) and maintenance dose oxytocin should be administered throughout the tamponade time.[6,30,33]

During infusion, the evaluation of the tamponade test begins. Significant reduction or absence of bleeding after partial or maximum balloon infusion are predictive of tamponade success, and the test is then considered positive. Usually, bleeding in the lower uterine segment stops after the infusion of 250 to 300 mL. Therefore, using balloons with a drainage function optimizes the tamponade test.[28]

The balloons can be inserted during or after cesarean sections. In these situations, the infusion should be reduced (250 to 300 mL) in order to avoid dehiscence in hysterorrhaphy. In the completed cesarean section, insertion is similar to that of vaginal postpartum. The insertion of the balloon during cesarean section should be performed preferably by the abdominal route (via hysterotomy) and is more difficult in balloons with a three-way. This difficulty can be overcome by removing the three-way, applying ties compressing the proximal axis of the balloon (infusion and drainage routes) and connecting a flexible probe to the balloon axis, adapting the probe as a guide so the balloon underpasses through the cervical canal. Another alternative is to introduce a surgical forceps through the vaginal route into the uterine cavity. After passing the balloon shaft downward, an assistant pulls the proximal end of the device, reconnects the three-way and performs the infusion. The proximal axis of the balloon is grasped by the forceps and pulled into the vagina. If these strategies are not successful, the balloon will be inserted through the vaginal route.[6,32,35,36] Another difficulty linked to tamponade with UBT in cesarean sections is maintaining the correct positioning of the device in the uterine cavity during hysterorrhaphy and uterine manipulation. The technique of "fishing" the balloon axis can be used to prevent the device from moving during these steps. A surgical thread is tied to the distal end of the device close to the lower portion of the balloon. With the balloon positioned in the uterine fundus, the thread is pulled by the assistant in the cephalic direction through a repair, avoiding vaginal displacement (prolapse) of the balloon during hysterorrhaphy. After the balloon infusion is carried out vaginally, the thread must be cut close to the hysterorrhaphy.[36]

The length of stay of the UBT can be up to 24 hours. However, in case of hemorrhagic control and hemodynamic stability, early removal (12 hours) is indicated to prevent infection.[33,37] Deflation in stages (100 mL every 15 minutes) is recommended, although single-stage emptying is also acceptable. The emptying and removal of the UBT should be performed during the day with operating room scheduling and maintenance oxytocin infusion. In case of hemorrhagic recurrence during the removal process, the UBT must be reinfused and the patient prepared for laparotomy.[23]

When and how to use an intrauterine vacuum-induced hemorrhage control device?

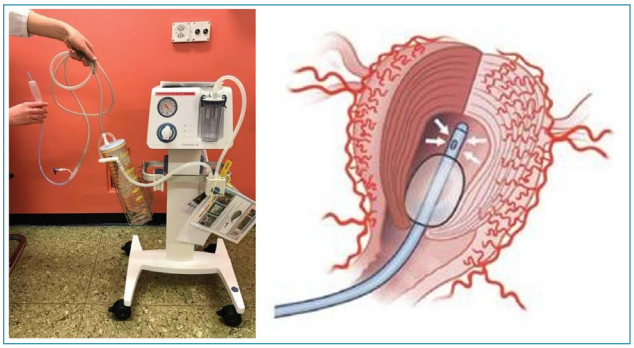
Currently, intrauterine vacuum-induced hemorrhage-control devices have emerged as a novel technology in the non-surgical invasive treatment of PPH. Intrauterine blood aspiration achieved through low-level vacuum (80 ± 10 mmHg) promotes continuous blood emptying of the uterine cavity, contractility of the uterine wall and compression of the myometrial vascular system with rapid hemorrhagic control. The Jada System is a device composed of an elliptical silicone distal loop containing 20 aspiration pores, a cervical seal (infused with 60 to 120 mL) and a tube for connection to an adjustable vacuum source and graduated container (Figure 5). To date, this is the most studied vacuum aspiration device, especially in uterine atony both in vaginal and cesarean PPH. It presents significant total success rates in both modes of delivery (92.5% vaginal and 83.7% cesarean). Its success rates in the treatment of isolated uterine atony reached 95.8% and 88.2% in vaginal and cesarean PPH, respectively. Like UBT, it appears to provide rapid hemorrhagic control right after the institution of vacuum aspiration (between one and five minutes). The time between device insertion and removal is reduced, with medians of 3.1 and 4.6 hours for vaginal and cesarean deliveries, respectively, which is recognized as an advantage over UBTs. The time interval between placental delivery and device insertion is greater in PPH linked to cesarean sections (median of 108 minutes) compared to vaginal births (median of 31 minutes), as insertion is only performed after completion of the surgical procedure, and through the vaginal route (motivated by the presence of the cervical seal).[38,39]

Source: Photographic record by the authors.

Figure 5. Jada System - Vacuum Induced Hemorrhage Control

Other vacuum aspiration systems have also been studied in the invasive treatment of PPH by adapting balloons or probes to the uterine cavity, also in both modes of delivery. The Bakri UBT connected to a vacuum aspirator can be adapted in the uterine cavity to promote continuous blood aspiration. By means of reduced infusion (50 to 100 mL), the balloon is fixed in the uterine segment. Its distal portion provided with blood drainage holes is positioned at the bottom of the uterine cavity, providing aspiration (Figure 6). Initial reports are of success rates exceeding 70% in PPH control with use both in the treatment of uterine atony and placental pathologies.[40]

Gastric tubes inserted into the uterine cavity during cesarean sections and connected to aspiration systems have



Source: Adapted from Haslinger et al. (2021).[40]

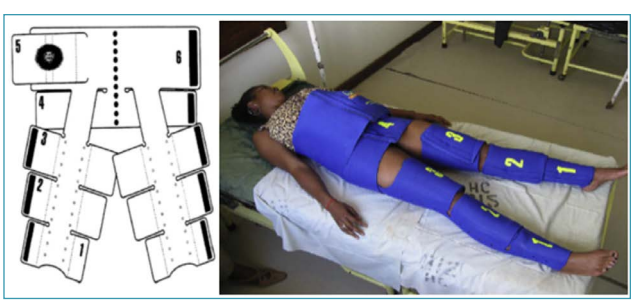
Figure 6. Left: vacuum-induced tamponade system using the Bakri intrauterine balloon; Right: schematic representation of the mechanism of action in vacuum-induced tamponade; detail of blood aspiration through the drainage holes of the balloon and the collapse of the spiral arteries in the uterine wall.

also had their viability and acceptability tested and approved. Insertion was performed via the abdominal route, with the proximal end of the probe passing through the hysterotomy, followed by vaginal apprehension and connection to the vacuum aspirator. The effectiveness of vacuum-induced uterine tamponade still requires further evaluation with the intention of supporting its recommendation in the non-surgical invasive treatment of PPH.[41]

When and how to use NASG?

The NASG is a segmented neoprene garment that covers the lower limbs and abdomen from the ankle to the last rib, applying external compression. It is a low-cost, easy-to-use and washable device, and an adjunctive non-surgical intervention in volume resuscitation and in the treatment of severe forms of PPH.[42]

The NASG is divided into six articulated segments, three in each leg (numbers 1, 2 and 3; positioned just above the ankles, on the calves and on the thighs), one for the pelvis (number 4) and two for the abdomen (numbers 5 and 6). Segment 6 includes a foam compression ball that is positioned over the umbilical scar (Figure 7). The well-fitted NASG applies a circumferential compression of 20 to 40 mmHg, forces blood flow to the upper limbs and central organs (brain, heart and lung) and provides increased blood pressure, preload and cardiac output.[42]



Source: Miller et al. [42]

Figure 7. Non-pneumatic anti-shock garment

The main benefit of NASG is reducing the speed of bleeding, which may reduce the need for blood transfusion and additional surgery. Other advantages include the facilitation to obtain venous access, possibility of maintaining its use during perineal approaches (surgical and clinical) and laparotomy, and the gain of extra time for the etiological diagnosis, volume resuscitation, pharmacological treatment and patient transfers.[9,42]

The NASG is indicated in case of bleeding with hemodynamic instability or imminent shock, and can be used in association with other invasive treatments (UBT, surgeries). Contraindications include a live viable fetus, severe heart disease (heart failure, mitral stenosis), severe respiratory disease (pulmonary hypertension, acute lung edema) and supradiaphragmatic injury.[42]

Both placement and removal should be performed from segment 1 to 6 (from the ankle to abdomen), except in the case of laparotomy, in which the abdominal segments (5 and 6) can be removed separately at the time of surgery. During the application, each segment must have its velcro well fitted and closed with adequate tension, keeping the joints (ankle, knee and hip) free. After placement, the NASG allows complete perineal access, thereby providing continuity of care (surgical procedures, uterine compression maneuvers).[6,9]

The removal of the NASG must occur in hemodynamic stability and conditions to perform additional interventions. Blood loss <50 mL/hour, HR <100 bpm, SBP> 100 mmHg, hemoglobin (Hb) > 7 g/dL and hematocrit (Ht) > 20% are the recommended parameters for removal. The removal process must occur under hemodynamic monitoring, and the time interval between the removal of segments must be 20 minutes, allowing the redistribution of blood flow. The absence of a drop in SBP by 20 mmHg or a HR increase by 20 bpm is a parameter that can guide the progress of removal. The details of the removal process are justified by the possibility of a shock recurrence in inappropriate removals. In the event of recurrence of hemodynamic instability or bleeding, the NASG must be repositioned and additional treatments instituted. In the laparotomy situation, in which abdominal segments (5 and 6) are removed before the others, this must occur immediately before the procedure with an expected drop in blood pressure.[9]

Although the length of stay of the NASG is not well defined yet, it is often between six and eight hours. However, there are reports of its safe use for up to 48 to 72 hours.[6]

How should the hemostatic resuscitation management be?

It is estimated that 0.6% of deliveries require a hemotherapy approach motivated by hemorrhagic shock.[33] In this context, knowledge of the principles of hemostatic resuscitation and the institutional presence of a massive blood transfusion protocol, including emergency transfusion flow, are essential in birthing centers.[9]

In addition to the rapid control of bleeding and the restoration of tissue perfusion, the aim of the strategy for hemorrhagic shock treatment is an early approach to coagulopathy and hypothermia. Temperatures below 35 ºC reduce tissue oxygen perfusion, favor acidosis and aggravate coagulopathy.[6,9]

In volume resuscitation, the response should be assessed for every 500 mL of infused crystalloids. The rapid and excessive infusion of crystalloids can raise blood pressure before surgical control of the hemorrhagic focus, paradoxically increasing bleeding (destruction of formed clots), favoring hypothermia (unheated liquids) and diluting coagulation factors, which increases the risk of dilutional coagulopathy and progression to the deadly triad. After infusion of 1,500 mL of crystalloids, especially in the presence of active bleeding, hemodynamically unstable patients should be evaluated for immediate blood transfusion. After infusion of 2,000 mL of crystalloids, resuscitation should continue with blood components.[6,9]

The SI is useful in predicting the need for blood transfusion. As Hb and Ht measurements take a while to change, they are not useful parameters in the initial management of hemostatic resuscitation.[6, 9, 22, 23]

Current transfusion protocols are varied and based on trauma studies. However, as the evolution to hypofibrinogenemia is earlier in PPH, this is an important aspect to be considered in hemostatic resuscitation. Fibrinogen levels below 200 mg/dL have a 100% positive predictive value for severe PPH. Therefore, an aggressive approach to hypofibrinogenemia is essential.[43]

The initial transfusion decision should be based on the patient's clinical status (SI). The proportions of the use of blood components and the transfusion goals must be included in the protocols. Hemostatic resuscitation is usually necessary in patients with no clinical response to initial volume replacement with crystalloids. Hemodynamically unstable patients with significant losses should receive emergency transfusion of two red cell concentrates. If cross-testing is not available, O negative blood should be transfused. In mild shock (SI ≥ 1), blood transfusion is usually not necessary and, if it occurs, it must be performed with compatible typed blood. In the face of severe shock (SI> 1.7), transfusion must be massive, immediate and performed preferably with equal proportions of packed red blood cells, fresh frozen plasma, cryoprecipitate and platelets. Fibrinogen must be measured and, when available, viscoelastic tests may contribute to reduce the use of blood components. Therapeutic targets are Hb> 8 g/dL, fibrinogen between 150 and 200 mg/dL, platelets> 50,000/mm^3 and INR ≤ 1.5.[6, 9]

Final considerations

Since PPH is the major cause of maternal mortality in the world, it is essential that care teams are able to prevent, diagnose and institute non-surgical management within the "golden hour". The need to simultaneously perform multiple actions for an adequate therapeutic management of PPH justifies the presence of an orderly work system in care centers. For the reduction of risks and morbidity and mortality from PPH, it is necessary to implement risk stratification in health services and reduce difficulties in the management of patients through the early identification of risk factors and optimization of antenatal, childbirth and post-natal care. The systematic use of prophylactic oxytocin and of active management of the third stage, as well as an efficient method of estimating blood loss combined with the appropriate diagnosis and therapeutic, are practices that should be offered in a standardized and uniform manner by care teams. The availability of UBT, intrauterine vacuum devices, NASG and blood components, the knowledge of actions that reduce morbidity and mortality and the development of professional skills for the correct use of these supplies complement the care needs for an adequate non-surgical management of PPH. Finally, the valorization of women's lives, the organization of local health systems and establishment of programs dedicated to preventing maternal mortality, optimizing health professionals' skills and eliminating barriers to care access are essentially the greatest challenges to reduce PPH morbidity and mortality.

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Apoio:

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