POSTPARTUM HAEMORRHAGE: PREVENTION AND TREATMENT

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1. INTRODUCTION. DEFINITION

The most accepted definition of postpartum haemorrhage (PPH) is the clinical one, which considers PPH as a blood loss higher than expected in the postpartum period that triggers signs or symptoms of hypovolaemia.

Postpartum haemorrhage can occur in 1-5% of births (severe PPH in 0.2-0.4%) and is considered the leading cause of maternal mortality worldwide.

Depending on its onset, it is classified into:

- Primary / Early: during the first 24 hours postpartum
- Secondary / Late: from 24 hours to 6-12 weeks postpartum

Severe PPH will be considered when the bleeding is greater than 1500 ml or in those cases with more than 4 units transfused during the first 24 hours.

2. AETIOLOGY AND RISK FACTORS

The causes of PPH can be simplified into “the 4 Ts”: TONE, TRAUMA, TISSUE, and THROMBIN. Multiple predisposing factors can be related to these causes (see Appendix I), and there are certain factors for increased risk of postpartum haemorrhage (Table 1). However, assessment of antenatal risk factors only predicts 40% of PPH cases, with Placenta Previa and Placenta Accreta being the most important identifiable risk factors for major bleeding. Nevertheless, 60% of PPH occur in women with no risk factors.

Table 1. Risk factors for postpartum haemorrhage.

High risk
– Placenta Previa. Suspected Placenta Accreta – Multiple pregnancy – Previous severe PPH – Thrombocytopenia (platelet count < 100 x 10^9/L) or other coagulation disorders with increased bleeding risk – Severe preeclampsia – Active intrapartum bleeding

– 2 or more intermediate risk factors
Intermediate risk
Antenatal factors: – Multiparity (> 4 previous births) – Advanced maternal age (> 40 years) – Several significant uterine fibroids – Haematocrit<30% – Fetal macrosomia (>4000 gr) – Severe polyhydramnios **Intrapartum factors:** – Prolonged second stage of labour (>3 hours) – Chorioamnionitis – Magnesium sulphate treatment

3. PREVENTION

Prevention measures to minimise PPH should be applied in all cases.

- Avoid predisposing factors
- ACTIVE management of the 3rd stage of labour:
  - Prophylactic use of uterotonics
  - Controlled cord traction to expedite delivery of the placenta

Mainly, the preventive use of uterotonics has been shown to significantly reduce the incidence of PPH, postpartum anaemia and the need for blood transfusion. Early cord clamping is no longer part of active management as it does not influence the risk of PPH and is not currently recommended. Moreover, there is no evidence that uterine massage is a useful strategy in the prevention of PPH.

Prophylactic uterotonic drugs should be recommended:

- **Oxytocin** (first choice): 3-5 IU given by slow intravenous injection or 10 IU by intramuscular injection
  - It is the most effective treatment with fewer side effects
  - Quick administration of oxytocin (< 30 seconds) produces maternal haemodynamic effects (hypotension and tachycardia) and electrocardiographic changes in some cases
  - It can be administered when the anterior shoulder comes out, just after birth or when the placenta comes out, since it does not increase the risk of retained placenta. There are no significant differences between any of these times of administration
  - Given the half-life of oxytocin (10-15 min), it is recommended to complement the prevention of PPH with the subsequent systematic administration of oxytocin by intravenous injection (10-20 IU diluted in 500 ml of 0.9% saline solution at 125 ml/h)
- **Carbetocin:** 100 µg given by slow intravenous route
  - Synthetic analogue of oxytocin with a longer half-life (40 min vs 10-15 min)

- Its use is recommended in caesarean sections with a high risk of PPH, that is, in patients with some high risk criteria for postpartum haemorrhage or 2 or more medium risk criteria as described in Table 1 of point 2 of this protocol
- The side and haemodynamic effects are the same as for oxytocin. Therefore, it is necessary to take the same precautions: caution in patients with asthma, cardiovascular diseases, migraine, evaluate for hyponatremia if administration of many fluids, etc.

4. DIAGNOSIS

The diagnosis of PPH is based on clinical observations with control of vital signs and physical examination, considering that blood loss is often underestimated. PPH is classified into different stages of severity according to the haemodynamic changes and clinical signs and symptoms presented by the patient (Table 2).

Table 2. Classification of severity of PPH.

Stage	Signs	Symptoms	Estimated blood loss
Mild	Systolic BP >80 mmHg HR 100-120 bpm	Weakness, sweating	>500 ml in vaginal birth >1000 ml in c-section
Moderate	Systolic BP 70-80 mmHg HR 120-140 bpm	Confusion, oliguria	1000-1500 ml
Severe	Systolic BP <70 mmHg HR >140 bpm	Lethargy, loss of consciousness, haemodynamic instability	>1500 ml

In the case of primary PPH, it is essential to make a correct aetiological diagnosis.
The “4Ts” with the corresponding predisposing factors (Table 1) facilitate the aetiological diagnosis.
In addition, mixed aetiologies must be considered, with an initial factor causing PPH that ends up triggering the rest of the mechanisms.

5. PPH EARLY MANAGEMENT

An initial management by an experienced multidisciplinary team is necessary to give a rapid response, with the involvement of obstetricians, anaesthesiologists, midwives, nurses, porters and nursing assistants. The participation of the haematologist or angiography radiologist may also be required in a second stage. Communication between team members is essential.

To prevent the deterioration of the patient and eventual complications, an early baseline evaluation and the request for help from the multidisciplinary team are necessary. The algorithm represented in Figure 1 enables a progressive, coordinated and step-based series of actions.

The use of simulation as continuous multidisciplinary training in the management of PPH is a useful and recommended tool to optimise the management of obstetric haemorrhage and improve results.

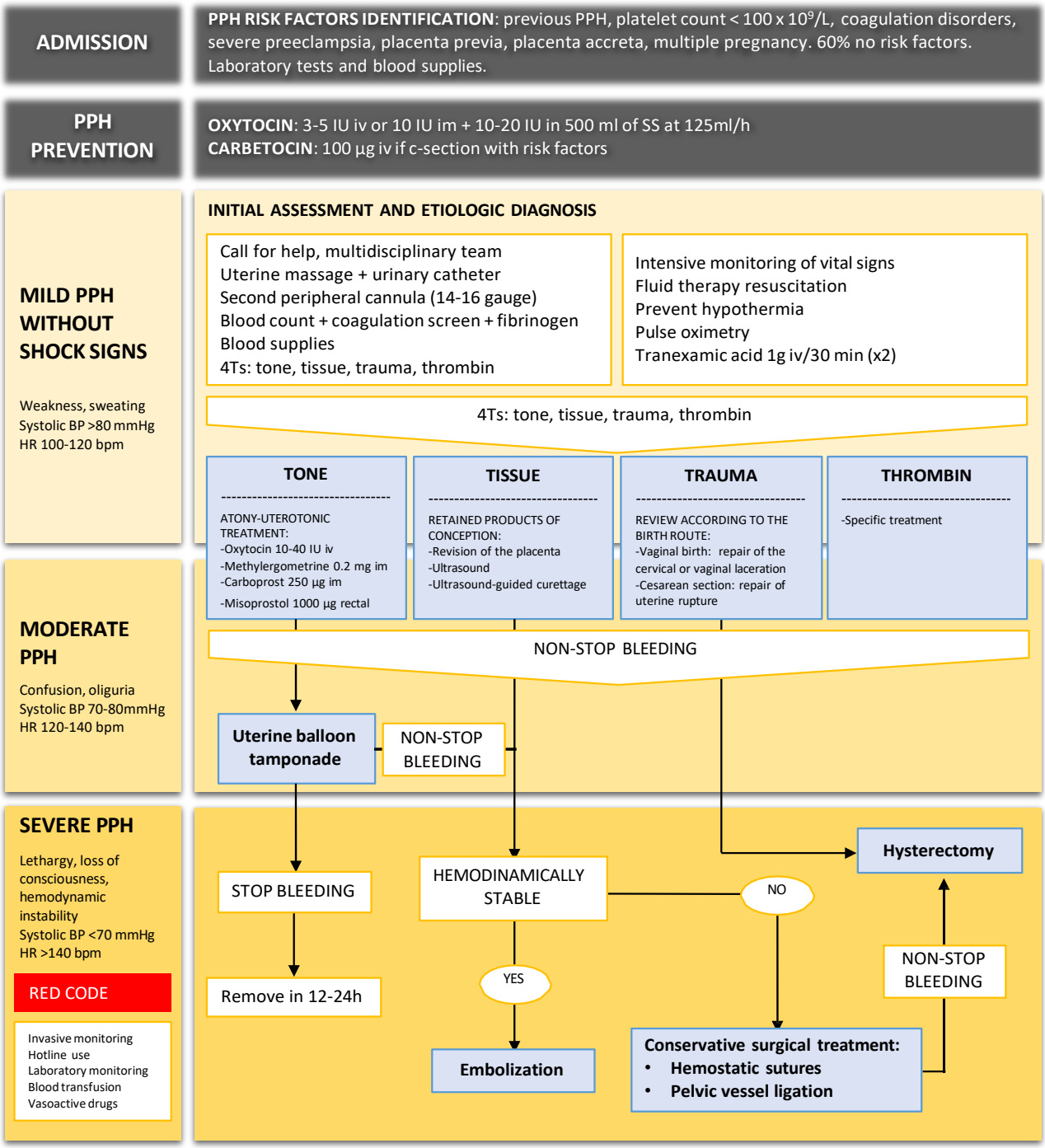


Figure 1. Management of obstetric haemorrhage.

In the initial management of PPH, patient monitoring, resuscitation, diagnosis and treatment should be carried out simultaneously.

5.1 EARLY MONITORING AND RESUSCITATION

- Continuous haemodynamic monitoring (non-invasive BP, HR, pulse oximetry)
- Oxygen therapy
- Fluid therapy: initial non-aggressive administration of balanced crystalloid and/or colloid infusion
- Placement of a second peripheral cannula (14-16 gauge)
- Baseline laboratory determinations: full blood count and coagulation screen
- Request for 2 cross-matched urgent units of red blood cells
- Blood gases and biochemistry with lactate
- Placement of a bladder catheter with urimeter to monitor urinary output
- Prevention of hypothermia for maintenance of body temperature
- Rational use of vasoactive drugs (ephedrine/phenylephrine)

Tranexamic acid: 1 g (10 ml of 100 mg/ml solution) intravenously administered over 10-20 minutes (infusion faster than 1 ml per minute causes hypotension). It is not an uterotonic, but antifibrinolytic agent. In case of PPH, early administration reduces maternal death and postpartum laparotomy, without increasing the risk of thrombosis; so it is recommended to give as soon as possible. According to the WOMAN trial, use from 3 hours PPH does not show benefit. No adverse effects have been reported. If bleeding persists after 30 minutes, a second 1 g dose may be administered.

5.2 DIAGNOSIS AND AETIOLOGICAL TREATMENT OF PHH

From the beginning, the therapeutic algorithm should be oriented according to the cause. Uterine atony is the main cause of PPH, but the aetiology can be mixed, so the "4Ts" (tone, tissue, trauma, thrombin) should be systematically assessed.

TONE

- Abdominal or bimanual uterine massage.
- Uterotonic treatment: the use of uterotonics will be necessary while the diagnosis and aetiological treatment is carried out.
- Uterine inversion is a rare cause of PPH and its specific management is detailed in Appendix II.

TRAUMA

- Review of the birth canal: a good operative field is important, with adequate light and instruments, and a good analgesia. A tear should be suspected in case of bleeding with a contracted uterus after delivery and no retained products of conception. Identification of a vulvar,

vaginal or cervical laceration will require surgical repair as the first option. Embolisation can be applied in some cases of cervical-vaginal tears and dissection of difficult-to-reach haematomas.

- In patients with previous uterine surgery, the possibility of uterine rupture (evidenced as PPH, haemoperitoneum, or shock), requires surgical repair or hysterectomy.

TISSUE

- Intrauterine revision: pelvic ultrasound or manual revision of the uterine cavity and removal of retained products of conception are recommended. If manual removal is not possible, the recommended treatment is ultrasound-guided uterine curettage and the subsequent administration of uterotonics.
- In case of suspicion of placenta accreta, it will be necessary to act according to the specific protocol. It is not recommended to pull excessively so as not to increase the risk of massive bleeding. Hysterorrhaphy with be performed with the placenta in situ and hysterectomy or conservative treatment will be considered later.
- In those cases in which the placenta is difficult to obtain and areas of partial placental accretism are suspected, ultrasound-guided uterine curettage can be considered as the initial treatment, with the subsequent administration of uterotonic drugs. Intrauterine balloon placement, uterine compression sutures, or embolisation may also be helpful strategies.

In case of intrauterine manipulation (manual removal of the placenta or uterine curettage) or vaginal tears (according to specific protocols), antibiotic prophylaxis will be recommended with a single dose of 2 g intravenous cefazolin (if allergies: a single dose of 900 mg intravenous clindamycin).

THROMBIN: coagulation disorders

Coagulation disorders, whether hereditary or acquired, will require specific treatment depending on the causative factor (transfusion of platelets, plasma or cryoprecipitates). In the case of the von Willebrand disease (most common hereditary coagulopathy), the use of desmopressin or DDAVP (synthetic analogue of vasopressin) will be necessary.

Table 3. Uterotonics for PPH treatment

UTEROTONIC AGENT	DOSE	ROUTE	FREQUENCY	ADVERSE EFFECTS	PRECAUTIONS AND CONTRAINDICATIONS
OXYTOCIN	10-40 IU in 500 ml isotonic crystalloids	Intravenous		Antidiuretic effect (risk of pulmonary or cerebral oedema) Nausea, vomiting Hypotension, arrhythmia or	Lung disease, heart disease, nephropathy, severe liver disease
	10 IU	Intramuscular			
	5 IU	Intravenous by			

		slow injection (3-5 min)		cardiac arrest if quick administration	
METHYLERGOMETRINE	0.2 mg 0,125 mg	Intramuscular Intravenous	Every 2-4 hours (maximum 5 doses)	Hypertensive crisis, vasospasm Nausea, vomiting	Hypertension, heart disease or cardiovascular risk factors Nephropathy, liver disease Systemic infection
CARBOPROST	250 µg	Intramuscular	Every 15-90 min (maximum 2 mg, 8 doses)	Bronchospasm Diarrhoea, nausea, vomiting Hypertension, hypotension Fever, headache, flushing	Lung disease, heart disease, nephropathy, sever liver disease Relative contraindications: hypertension, asthma, glaucoma, epilepsy
MISOPROSTOL	1000 µg	Rectal	Every 2-6 hours	Fever diarrhoea, nausea, vomiting	Hypersensitivity

6. ADVANCED PPH MANAGEMENT

When bleeding is severe or worsens, it will be essential to follow the therapeutic algorithm both in obstetric management and in resuscitation by the anaesthesiologist (Figure 1).

6.1 ADVANCED OBSTETRIC MANAGEMENT

6.1.1 Intensify uterotonic treatment (Table 3): use of carboprost.

6.1.2 Non-medical conservative treatment

If medical treatment is not enough to manage PPH, it will be necessary to apply conservative surgical techniques (intrauterine balloon, uterine compression sutures, pelvic vessel ligation, embolization) to avoid hysterectomy, considered as the last therapeutic option. The efficacy of conservative techniques seems to be comparable between them, so the choice will have to be individualised based on other factors (way of delivery, possibility of transfer and embolisation, haemodynamic stability of the patient, experience of the obstetrical team). The intrauterine balloon is considered the first option due to its simple insertion and effectiveness. In case of failure, conservative surgical techniques or embolisation would be the alternative (Figure 1).

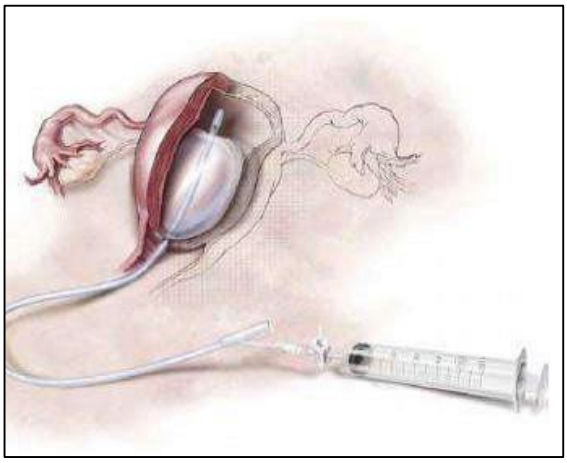
UTERINE BALLOON TAMPONADE

Intrauterine tamponade is an effective and easy-to-apply method. It provides time (to plan the next action, to wait for senior staff or for eventual transfer), but it is often a therapeutic manoeuvre by itself with success rates in stopping bleeding of over 90%.

In our setting, the **Bakri balloon** (Cook®) is used as the first-choice method. In the absence of a Bakri balloon, other alternatives are the use of the Foley catheter, oesophageal Sengstaken tube, urological Rusch balloon or gauze packing.

Placement technique:

- Ensure the absence of retained products of conception and uterine rupture
- Urinary catheter placement to monitor urine output
- Bakri balloon insertion (ultrasound-guided if necessary)
- Fill the Bakri balloon with 300-500 ml of sterile water or saline or lactated Ringer's solution
- Use ultrasound to confirm that the balloon is properly placed



The Bakri balloon is a latex-free device.

The Bakri balloon consists of two lines, the filling port and the drainage port. The drainage port connects to a fluid collection bag to allow measurement of blood loss. If necessary, a gauze packing may be placed in the vagina to prevent the balloon from coming out.

In the case of a caesarean section, the intrauterine balloon can also be placed. The placement is usually vaginally once the caesarean section is completed, or abdominal (from the uterus to the cervical canal) prior to the hysterorrhaphy, taking care not to perforate the balloon with the suture. The balloon will fill once the suture is finished.

In the event that bleeding persists once placed, it will be necessary to combine balloon tamponade with uterine haemostatic suture, known as "uterine sandwich".

The balloon indwelling time after control of bleeding is 12-24 hours. The emptying of the balloon can be carried out progressively (100 ml/h) or in two stages.

Prophylactic antibiotic treatment with amoxicillin-clavulanic 1 g/200 mg intravenously every 8 hours (or clindamycin 300 mg intravenously every 6 h in case of allergy) is indicated while balloon intrauterine tamponade is maintained.

HAEMOSTATIC SUTURING

The haemostatic suture is an easy-to-apply conservative surgical technique. The aim of this technique is to achieve contact and compression of the uterine walls.

Indication: is useful in uterine atony when bimanual compression of the uterus stops bleeding.

Techniques: there are different techniques described. The most common are the B-Lynch suture technique and the Hayman suture, both described in Appendix III.

EMBOLISATION BY INTERVENTIONAL RADIOLOGY

Embolisation is a minimally invasive endovascular conservative treatment that consists of performing an arteriography to locate the bleeding vessel and then occlude it with absorbable gelatin particles (Gelfoam). Non-absorbable particles (coils or PVA) are used only in cases of arteriovenous malformations, significant arterial injury, or placenta accreta.

It is usually performed under local anaesthesia, but general anaesthesia may be required.

The procedure lasts about 30-60 minutes, and is carried out by angiography radiologists, with an efficiency of 88-97%. Therefore, it is a very effective non-surgical treatment. Its availability is its main drawback.

Indications: severe PPH in a haemodynamically stable patient, cervical-vaginal lacerations or placental accreta.

Complications: post-procedure fever and risk of necrosis.

PELVIC VESSEL LIGATION

Bilateral uterine artery or internal iliac artery ligation are useful techniques, especially when embolisation is not available and if performed by surgeons trained in this technique.

Hypogastric/internal iliac artery ligation may be useful as a rescue technique after hysterectomy. It is a challenging technique, even for an experienced pelvic surgeon.

Appendix IV explains the different techniques.

6.1.3 Hysterectomy

It is an effective and known technique for the gynaecologist, with the obvious disadvantage of not preserving the uterus or fertility.

SUBTOTAL: easier and faster.

TOTAL: in case of prolonged laceration to the cervix, placenta previa or placenta accreta.

In obstetric hysterectomy, the uterine arteries should be ligated or clamped before the rest of the pedicles to reduce bleeding.

It is considered a rescue technique in case of failure of medical and conservative surgical techniques.

6.2 ADVANCED RESUSCITATION OF SEVERE OBSTETRIC HAEMORRHAGE AND HAEMORRHAGIC SHOCK

Obstetric haemorrhage has a sudden onset and can rapidly progress to haemorrhagic shock because a large volume of blood crosses the placental exchange space in a short time (600-700 ml per minute).

Diagnosis in an obstetric patient is usually late because they have a high tolerance to large blood loss. The parameters used to assess shock, such as blood pressure, heart rate, mental state, and oliguria are parameters with low sensitivity and specificity, so there is a tendency to underestimate subclinical hypoperfusion states. Given the differential characteristics of the obstetric patient, in 2017 the European Society of Anaesthesiology published guidelines with special recommendations regarding obstetric bleeding. Regardless of when resuscitation is started, volume replacement and administration of blood products (± vasoactive drugs) will be guided by haemodynamic and analytical goals. Bear in mind that vasoactive drugs are an adjuvant treatment, but not aetiological.

Advanced resuscitation may involve:

- Establish invasive monitoring (arterial and central venous line). Non-invasive monitoring of cardiac output
- If there is reduced consciousness or progressive haemodynamic instability, ensure oxygenation by increasing FiO_2 or proceed to intubation and mechanical ventilation
- Avoid hypothermia by using Hotline® and warm air blankets

6.2.1 Haemodynamic and analytical objectives

Resuscitation goals	Value
Systolic BP*	90-100 mmHg
Heart rate	<100 bpm
Central venous pressure	>6 mmHg
Cardiac index	>2.5 L/min/m^2
Lactate	<22 mg/dL
pH	>7.20

*Systolic BP has been adjusted in case of preeclampsia or chronic hypertension

6.2.2 Haemodynamic and analytical monitoring

It is advisable to place an arterial line and central venous access not only to monitor invasive arterial pressure and central venous pressure, but also to treat hypovolemia, anaemia, and laboratory sampling.

Monitoring of laboratory parameters consists of:

- Point of care testing: blood gases, haematocrit and ionised calcium. The frequency of sample analysis will be adapted to obtain maximum control

- Laboratory: blood count, biochemistry with lactate and coagulation screen. The frequency will be at least every 30 minutes in active bleeding, and adapted to the patient's condition once stabilised

6.2.3 Fluid therapy

Currently, the use of balanced crystalloids and colloids is recommended. Avoid aggressive resuscitation with a large volume, since it causes haemodilution and worsens coagulation parameters.

6.2.4 Blood transfusion and coagulation factors

PACKED RED CELL UNITS, PLATELETS AND FROZEN PLASMA

Early administration of packed red cell units and fresh plasma with a 1:1 transfusion ratio.

The current algorithm for managing obstetric haemorrhage suggests transfusion with:

- Fresh frozen plasma if INR >1.5
- Platelets if platelet count <50 x 10^9/L
- Cryoprecipitate or fibrinogen if fibrinogen <2 g/dL

A suboptimal **haematocrit** in the acute phase of PPH is associated with severe organ dysfunction. Although there is no scientific evidence on the trigger haemoglobin value to start the transfusion, it would be reasonable to establish it around 7-8 g/dL or 7 g/dL in asymptomatic patients without active bleeding.

Fibrinogen levels less than 2 g have a 100% positive predictive value for major obstetric haemorrhage. Therefore, in the case of fibrinogen < 2 g, the initial dose of fibrinogen will be 4 g (1 g intravenously over 10 minutes). Fibrinogen should be dissolved in 50 ml of water per injection without shaking the bottle (it takes about ten minutes to dissolve).

Resuscitation with colloids and crystalloids and massive transfusion causes dilutional thrombocytopenia. In addition, platelet function is impaired by anaemia and by increased fibrinogen degradation products. In active bleeding we should maintain at least a number of **platelets** > 50 x 10^9/L.

PROTHROMBIN COMPLEX

Prothrombin complex contains coagulation factors II, VII, IX, and X. Its use is only indicated in patients treated with dicumarinic anticoagulants, as indicated in its data sheet.

RECOMBINANT FACTOR VII

Recombinant factor VII is not a first-line drug. Some authors recommend its use as a therapeutic rescue option, after replacement of a minimum level of fibrinogen, platelets and control of temperature, plasmatic calcium and pH to obtain a good response to its administration.

6.2.5 Red code

The existence of transfusion protocols such as **RED CODE** facilitates the massive transfusion in cases of live-threatening obstetric haemorrhage.

When a red code is activated, uncrossmatched 4 packed red cell units, 4 g of fibrinogen and 4 frozen plasma units are immediately initially administered.

After that, the patient will be re-evaluated and the multidisciplinary team will decide whether or not to continue with the transfusion of packed red cell units/frozen plasma with a 1:1 ratio. From that moment on, the blood should already be cross-matched, whenever possible. Fibrinogen will continue to be administered if the determination is <2 g/L and active bleeding persists. It will not be administered, in any case, with determinations > 2 g/L.

Depending on the bleeding, the clinical situation and the laboratory determinations, additional platelets will be requested in the laboratory and administered in a ratio of 1:1:1 (take into account that a therapeutic unit corresponds to 5 real units). Therefore, a unit of platelets will be transfused for every 4-5 packed red cell units, unless we have a recent platelet determination greater than 80 x 10^9/L.

6.2.6 Summary of objectives in the blood transfusion of the obstetric patient

Parameter	Value
Haematocrit/Haemoglobin	27-30% / 9-10 g/dL
Platelet count	50 x 10^9/L
Fibrinogen	2 g/L
Ionised calcium	normocalcemia
Temperature	35ºC

6.3 TRANSFER OF PATIENTS WITH SEVERE OBSTETRIC HAEMORRHAGE

After the stabilisation of the patient with severe PPH, regardless of the surgical treatment performed, the multidisciplinary team will consider transfer to the ICU to continue intensive treatment.

7. SUBSEQUENT PPH MANAGEMENT

Once the PPH has been resolved, in addition from the general puerperal measures, some specific aspects must be taken into account:

- **Puerperal anaemia control**: blood test once the acute moment has been overcome, at least 6 hours after the last transfusion (in haemodynamically stable women), to assess and treat puerperal anaemia. The options of treatment are:

  - Oral iron if haemoglobin 6-9.9 g/dL
  - Intravenous iron in women without transfusion criteria who present intolerance to oral iron, malabsorption, or poor compliance with oral treatment
  - Transfusion if haemoglobin < 6 g/dL and symptomatic patient or associated comorbidity
- In the case that the patient had presented persistent significant hypotension, adrenal insufficiency secondary to **Sheehan syndrome** should be ruled out early by laboratory control of glucose, iongram, blood gases, urea, creatinine and sodium in urine.
- **Thromboprophylaxis**: PPH is a risk factor for puerperal thrombosis. Therefore, if coagulation tests are normal, thromboprophylaxis with low molecular weight heparin will be indicated (according to the specific protocol) 12-24 hours after resolution of the symptoms. In addition, during the first hours after PPH, the use of compression tights can be considered whenever possible.

APPENDIX I. PPH AETIOLOGY AND RISK FACTORS

PPH	AETIOLOGY	RISK FACTORS
TONE **Uterine atony (75-80%)**	Overdistension of the uterus	Multiple pregnancy Fetal macrosomia Polyhydramnios Fetal congenital defects Hydrocephalus
	Uterine muscle fatigue	Rapid labour Prolonged labour Multiparous women
	Intraamniotic infection	Prolonged PROM Fever
	Uterine abnormalities	Uterine fibroids Placenta previa
	Tocolytic drugs	Betamimetics, nifedipine, magnesium sulphate, anaesthetics
	Uterine inversion	Fundal placenta Excessive cord traction Multiparous women
TRAUMA	Lacerations of the cervix, vagina or perineum	Instrumental delivery Rapid labour Episiotomy
	Extensions, lacerations at caesarean section	Fetal malposition Intrauterine fetal handling Advanced planes of Hodge
	Uterine rupture	Previous uterine surgery
TISSUE	Retained products of conception (placenta or membranes) Retained blood clots	Previous uterine surgery Placental abnormalities (succenturiate placenta, accessory cotyledon)
THROMBIN **Coagulation disorders**	Pre-existing coagulation disorders	Haemophilia Idiopathic thrombocytopenic purpura von Willebrand's disease Hypofibrinogenemia Family history of coagulopathy
	Coagulation disorders acquired in pregnancy	Gestational thrombocytopenic Pre-eclampsia, HELLP Disseminated intravascular coagulation (pre-eclampsia, in utero fetal demise, infection, abruption, amniotic fluid embolus)
	Anticoagulant therapy	History of thromboembolic disease

APPENDIX II. UTERINE INVERSION

The uterine inversion occurs when the uterine fundus collapses into the endometrial cavity, turning the uterus partially or completely inside out. Physical examination shows a cervical or vaginal mass with the non-palpation of the uterine fundus in the pelvis. It is a serious condition, with bleeding, pain and neurogenic shock, which requires urgent action with adequate anaesthesia.

The first line treatment is the prompt manual replacement through the vagina, pushing the uterine fundus into the pelvic cavity (Figure 2a). In case of intense uterine contraction, uterine relaxant drugs may be required (betamimetics, magnesium sulphate, nitroglycerin, halogenated gases). If manual reduction fails, the hydrostatic reduction method with pressurised flow of saline serum can be tried before proceeding to surgical techniques (Figure 2b). Surgical option consists of laparotomy and traction of the round ligaments with clamps or the fundus with a traction point, generally clamps or more rarely with a vacuum (Figure 2c).

Once reduced, the uterus will need to be held in place by the clinician's hand and a vigorous uterotonic treatment applied to prevent recurrence.

Figure 2a. Manual replacement of the inverted uterus.

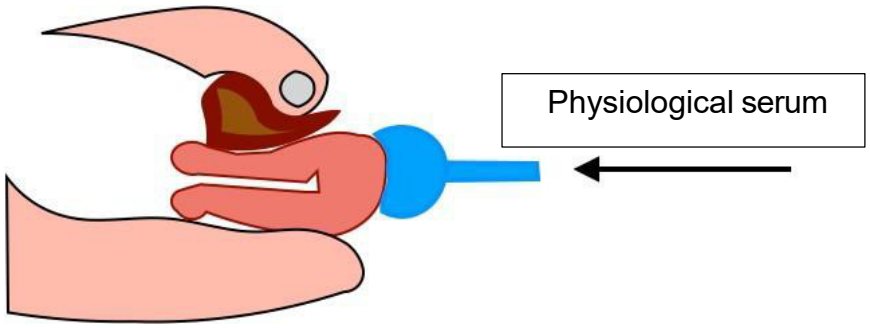


Figure 2b. Hydrostatic method by placing a vacuum on the uterine fundus with saline pressurised flow.

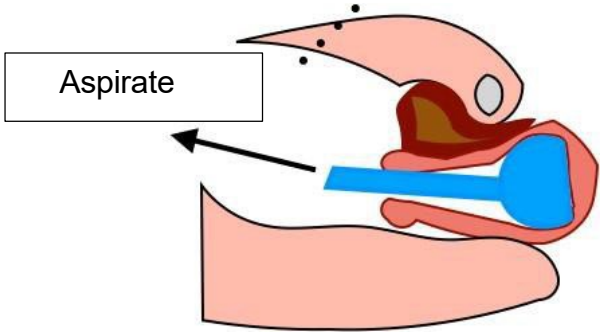


Figure 2c. Laparotomy to resolve uterine inversion. The use of a vacuum as a fundal traction point may be useful in replacing the uterus in the pelvis.

APPENDIX III. HAEMOSTATIC SUTURING

All uterine sutures will be performed with absorbable sutures. The specific suture kit available in the delivery room consists of PGA 1 suture with a 110 mm curved needle and 120 cm thread length or Vicryl® 2 with the largest cylindrical needle available.

Haemostatic sutures have a reported efficacy of 75% to 100% and are technically easy to perform. The complications described are ischaemic complications, uterine necrosis, infections, or the possibility of strangulation of nearby structures in case of suture migration.

B-LYNCH SUTURE

- B-Lynch suture requires laparotomy (in case of vaginal delivery, see Hayman suture)
- The suture begins at the edge of the hysterotomy and is looped over the uterine fundus and re-enters the lower uterine cavity through the posterior wall.
- Then, it crosses to the other side of the lower uterine segment, exits through the posterior wall, and is looped back over the fundus to enter the anterior lateral lower uterine segment opposite and parallel to the initial bites.
- The free ends are pulled tightly and tied down securely to compress the uterus, assisted by bimanual compression.

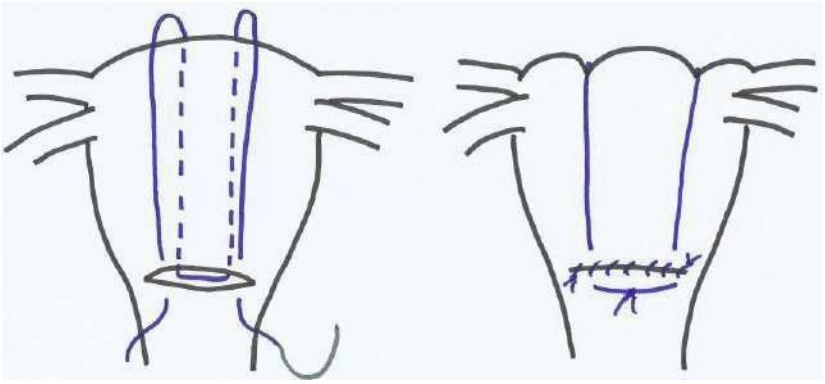


Figure 3. B-Lynch suture

HAYMAN SUTURE

The Hayman suture is a modification of the B-Lynch suture that does not require hysterotomy. Technically simpler and faster. It is achieved by placing a suture from the uterine segment area to the fundus, looping from the anterior to the posterior wall. Normally, it consists of 2 sutures, one on the right and one on the left side, but more can be done. It is recommended to place an additional suture at the fundus, between the two longitudinal sutures, to avoid their displacement.

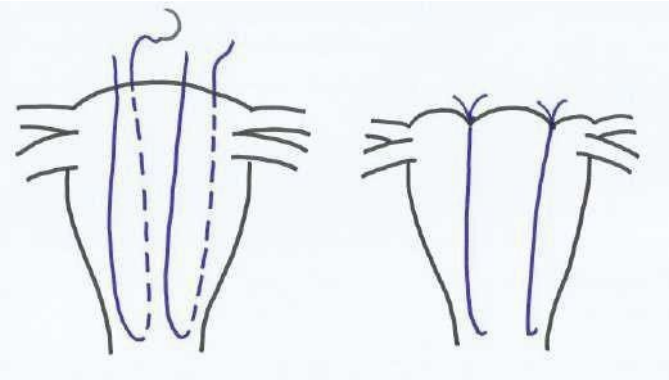


Figure 4. Hayman suture

APPENDIX IV. PELVIC VESSEL LIGATION

Uterine arteries ligation

Uterine arteries ligation can be performed in the following ways:

- Simple ligation with Vicryl® 1
- O'Leary suture consisting of ligation of the uterine artery and vein, including 2-3 cm of myometrium
- Including the terminal part of the ascending branch (utero-ovarian artery) or placing a second suture 2 cm lower to ligate the cervical branches

It is a procedure that must be performed bilaterally. It is advisable (especially in the case of low sutures) to locate the ureter in order to avoid injuring it, since this would be the most frequent complication.

Internal iliac or hypogastric artery ligation

It can be applied as a conservative technique, but also as a rescue technique after the hysterectomy.
The technique follows the next steps:

- A Pfannenstiel or infra-umbilical midline incision is necessary
- Achieve an adequate surgical field with adequate separation of the intestine and uterus
- Open the peritoneum 8 cm caudally from the common iliac artery bifurcates into the external and internal iliac artery branches
- Identify (medial to the hypogastric artery) and separate the ureter by digital dissection
- Individualise the internal iliac vein with a dissector, from lateral to medial (to avoid injuring the iliac vein), and clamp it (about 2-3 cm from the bifurcation in order to clamp the anterior branch)
- Ensure by pulse evaluation that the external iliac artery has not been clamped and ligate the internal iliac artery.
- Preferably use an absorbable suture (Vicryl 1) or, as a second option, double silk ligature
- Do not section the internal iliac artery
- Perform the procedure bilaterally

This procedure has a higher risk of necrosis than uterine artery ligation, but a lower risk of ureteral injury. However, it is a more complex technique to perform.
In the case of performing it after an obstetric hysterectomy, it should be taken into account that it can make future embolisation difficult.

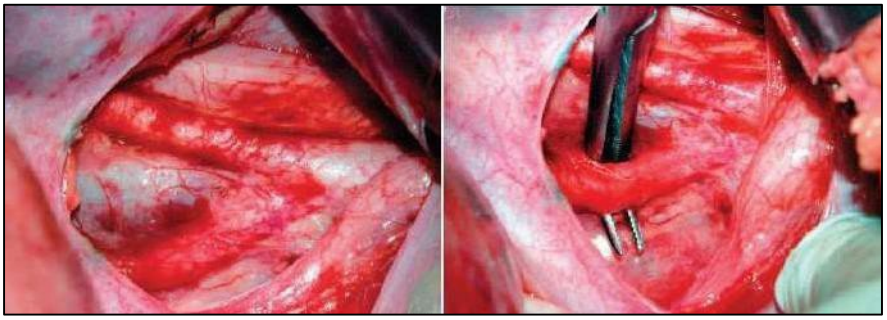


Figure 5. Hypogastric artery ligation (Joshi VIM et al. BJOG 2017;114(3):356-61)