Obstetric haemorrhage

Major haemorrhage is defined as a haemorrhage in excess of 15% of circulating volume (typically 1000 mL using an estimated blood volume at term of 90 mL kg\(^{-1}\)). Massive haemorrhage is usually defined as blood loss in excess of 1500 mL in pregnancy, labour, or following delivery, or continuing loss in excess of 150 mL min\(^{-1}\).

- The median blood loss at caesarean section is about 500 mL. Sometimes it can rapidly transform into massive haemorrhage.
- Tachycardia, hypotension, and vasoconstriction in an obstetric patient represent severe hypovolaemia.
- Coagulopathy may cause haemorrhage. Haemorrhage causes coagulopathy.

There are appropriate immediate actions as below; and further considerations for antepartum and postpartum haemorrhage follow. The successful management of haemorrhage includes obstetric management specific to the cause of the haemorrhage – usually delivery for antepartum haemorrhage and uterine contraction or surgical repair for postpartum haemorrhage. Improved survival from massive transfusion over the past ten years is attributed to more effective efficient warming devices, aggressive resuscitation and component therapy and improved blood banking. Early recognition and effective action prevent shock and its consequences.

**When continuing massive haemorrhage occurs, it threatens life: you must send for help. Do not attempt to manage it on your own.**

Consultant attendance

CEMD has made an unambiguous recommendation regarding obstetric haemorrhage [18]:

"If haemorrhage occurs, experienced consultant obstetric and anaesthetic staff must attend."

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Massive obstetric haemorrhage – put the call out

Aims
To resuscitate the patient and treat the cause.

Call for help
Pull the red emergency knob on diagnosis of MASSIVE OBSTETRIC HAEMORRHAGE – blood loss in excess of 1500 mL or 150 mL min⁻¹. MOH call.

Labour ward coordinator to call outside help – obstetric and anaesthetic consultants and residents.

Dedicated midwife to record all events and times.

One person to direct team tasks clearly.

Resuscitate
Airway, breathing and high flow oxygenation.

Circulation – two 14-gauge cannulas, blood warmers, pressure infusers such as Belmont. Consider intraosseous access – see page 58.

Prevent aortocaval compression if still pregnant.

Send bloods
FBC, coagulation screen + fibrinogen, phone blood bank (25398 / 25322 or bleep 2169) to check cross-match and electronic issue; consider cell salvage.

Monitor
Pulse, blood pressure, pulse oximetry.

Urine output.

Fluids
Warmed crystalloid till blood ready.

Infuse against pulse rate and other signs.

O Rh negative blood in blood fridge if desperate.

Group specific blood if emergency.

Give crystalloids with plasma-reduced blood.

Use a warming device with all intravenous fluids.

Use the rapid infusion device.
Obstetric haemorrhage

More monitors
- Invasive arterial blood pressure and ABG.
- Core temperature – check the patient warming device.
- Consider early use of cardiac output monitoring such as LiDCO or oesophageal Doppler.
- Consider CVP (do not impede volume resuscitation).

Operation
- May indicate general anaesthesia; use reduced doses, consider ketamine.

Drugs
- Uterotonics and systemic haemostatics. Start with tranexamic acid 1 g slow intravenous bolus.

More bloods
- Monitor ABG and laboratory values regularly.
- Anticipate and manage acidosis and coagulopathy.

Afterwards
- Obstetric high dependency care; consider critical care.

Massive haemorrhage call

In case of massive haemorrhage or when you expect cross-matched blood to be exhausted: call for senior help, then contact blood bank to discuss the patient’s needs. In a massive haemorrhage situation, with blood loss more than 1500 mL and continuing, you should also activate the massive haemorrhage protocol. With bleeding in the 1500-2000 mL range, and well controlled, MOH activation is not needed.

**Call 2222 and state ‘massive obstetric haemorrhage at location’**.

Activating the protocol will ensure blood bank and portering staff are aware of the need for assistance.

Remember to call 2222 and stand down the MOH call once the clinical situation is stable, and to complete the massive haemorrhage proforma.

Resuscitation

The priorities in resuscitation include in decreasing order of importance:

1. Restoring blood volume to maintain tissue perfusion and oxygenation.
2. Restoration of oxygen-carrying capacity with adequate haemoglobin concentration.

3. Securing haemostasis through surgical treatment of the cause of bleeding or by correcting coagulopathy.

Delay in restoration of circulating volume (with warmed crystalloid fluids, then blood) may result in tissue hypoperfusion, organ failure and disseminated intravascular coagulopathy [19].

Maintaining records

This is essential and can be forgotten as the clinical work proceeds. Keep in close touch with the midwife who will have allocated to act as the scribe.

Complications of resuscitation

Iatrogenic complications of resuscitation are important and you should be alert for them.

- Pulmonary oedema, occurring as a result of over-vigorous crystalloid or colloid therapy, or when associated with transfusion related acute lung injury (TRALI).

- Dilutional coagulopathy, occurring as a result of giving imbalanced or over-vigorous fluid therapy with insufficient blood components. Send samples at maximum intervals of two hours. TEG (thromboelastography) is available in cardiothoracic critical care.

Blood component transfusion is associated with risk and adverse outcomes in its own right. It is positively correlated with increased risk of:

- Multi-organ failure (MOF).
- Infection.
- Mortality (it is a better predictor of mortality than the Injury Severity Score).
- ICU admission.
- Prolonged ICU and hospital stay.
Obstetric haemorrhage

It is important to minimise transfusion by:

- Controlling haemorrhage effectively.
- Using red cell salvage as much as possible.
- Transfusing red cells for an indication, not just to improve a number (see page 66).
- Where red cell transfusion is indicated, giving the minimum number needed and rechecking. For example, many patients who do need a postoperative blood transfusion will only need one unit, and the next unit should only be prescribed after a further check.

Anticipation and prediction

Massive obstetric haemorrhage as defined above occurred in 7.2% of all caesarean sections carried out in Coventry between 2006-08, and 3.8% of all caesareans in 2011-12. This reduction is to be welcomed, but we can expect to see one case every eight days. It can also happen in any delivery, whether vaginal or caesarean, with no warning.

Certain conditions carry a greater risk. Caesarean section in labour, especially where labour is prolonged and a Syntocinon infusion has been used, is regularly followed by PPH, as is multiple delivery by caesarean section. Iron deficiency anaemia will reduce the ability to tolerate haemorrhage and may contribute to uterine atony through depleted uterine myoglobin levels.

Where a delivery is known to be one with a high risk of massive haemorrhage, for example placenta praevia, especially with previous caesarean section, myomectomy scars, uterine fibroids, placental abruption or previous third-stage complications, anticipative steps are essential.

- Antenatal anaemia should be checked and corrected in the antenatal period if possible [21].
- A consultant should perform all elective or emergency surgery.
- A consultant should give any anaesthetic.
Adequate intravenous access (two large bore cannulas) should be in place before surgery starts.

Check blood availability, whether electronic issue compatible or cross-match.

Consider inserting a preoperative arterial line.

Ensure the availability of intraoperative cell salvage.

**Estimation of blood loss and its effects**

Estimation is a continual process to keep the woman’s state under review. Visual estimation of peripartum blood loss is inaccurate; include clinical signs and symptoms in the assessment of haemorrhage [21].

With the circulating blood volume at term of typically between 90-100 mL kg\(^{-1}\) (in the case of morbid obesity this will be less) you should calculate the assumed starting blood volume, taking into account pre-theatre losses, to determine the proportion of blood that the woman has lost in order to compare it with the standard haemorrhage classes.

<table>
<thead>
<tr>
<th>Class 1</th>
<th>Up to 15%</th>
<th>No change in vital signs; fluid resuscitation not usually necessary.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2</td>
<td>15-30%</td>
<td>Peripheral vasoconstriction; use crystalloid (and salvaged red cells).</td>
</tr>
<tr>
<td>Class 3</td>
<td>30-40%</td>
<td>Peripheral vasoconstriction no longer compensates, so systolic blood pressure falls; use crystalloid and salvaged red cells, and allogeneic blood may be necessary.</td>
</tr>
<tr>
<td>Class 4</td>
<td>Over 40%</td>
<td>Immediate threat to life with cardiovascular collapse, unconsciousness at 50% loss; immediate transfusion and surgical intervention if not already in progress. May be manageable with salvaged red cells alone if done very well in theatre.</td>
</tr>
</tbody>
</table>

With an arterial line in place you should make serial estimations of the arterial pH, lactate, haemoglobin, haematocrit and base deficit.
Obstetric haemorrhage

measurements to guide management. Remember to send coagulation samples including fibrinogen levels regularly in communication with the blood bank technician.

Obstetric surgical management

Bimanual compression staunches haemorrhage effectively.

Internal tamponade or packing may precede operative intervention.

If bleeding is excessive or if pharmacological measures fail to control haemorrhage adequately, the obstetrician should consider either embolisation of uterine arteries by an interventional radiologist or further surgical procedures, such as internal iliac ligation, hysterectomy, B-Lynch suture (brace suture) or haemostatic square suture. Any obstetrician who does not feel competent to perform any of the above should immediately call a colleague to assist or, if necessary, a gynaecological or vascular surgeon.

Hysterectomy is indicated if bleeding continues despite deployment of an intrauterine balloon. It should not be delayed until the woman is in extremis or while less definitive procedures with which the surgeon has little experience are attempted [21].

As the obstetric anaesthetist, you should check that the operating obstetric surgeon has requested consultant assistance.

Intraosseous access

All resuscitation and anaesthetic drugs can be given via the IO route.

Fluids need to be administered under pressure.

An EZ-IO driver is available for use.

Indications

The need for rapid reliable vascular access and fluid resuscitation in a patient for whom intravenous access is difficult or too slow.

Contraindications

Bone trauma, prostheses or infection.
**Intraosseous method**

For obstetric haemorrhage, access above the uterus is recommended. Use the humeral head on the side at which you have most access, usually the left. Using the proximal humerus is associated with more rapid insertion and less pain (in the non-anaesthetised patient).

Bend the patient’s elbow and put their hand on their abdomen to rotate the humerus. Palpate the surgical neck of the humerus to locate the greater tuberosity. The insertion site is the most prominent aspect of the greater tubercle, approximately 1-2 cm above the surgical neck.

- Clean the insertion site.
- Attach the long yellow 45 mm needle to the EZ-IO driver.
- Support the limb and stabilize the bone.
- Push the needle tip through the skin and soft tissue at a 45-degree angle, aiming towards the opposite scapula, until the tip rests against the bone.
- For the needle to fit appropriately, at least 10mm (one black marker line on the needle) should still be visible before drilling.
Obstetric haemorrhage

- Gently drill into the humerus 2 cm at full drill speed until there is a sudden decrease in resistance or until the hub reaches the skin in an adult. The hub of the needle set should be perpendicular to the skin.
- After this change in resistance, stop and stabilise the hub with one hand, pull the driver off and then unscrew the stylet counter clockwise and remove it.
- The needle should still feel firmly seated in bone. Aspiration of marrow helps to confirm placement but this is not always possible.
- After removing the stylet, place the stabiliser over the hub and attach a primed extension set. Flush the system should be flushed with 1 mL 2% lidocaine and 10 mL fluid and attach an IV giving set.
- Secure the arm in place and do not lift it – this will dislodge the IO needle.
- Flush the needle with at least 10 mL of fluid after drug administration.
- Due to the intrinsic pressure of the intraosseous space, infusions commonly do not flow effectively with gravity alone and need to be administered under pressure e.g. using pressure bags, syringe driver or manual flushing.
- Assess the IO site frequently for signs of extravasation.

Do not take an arterial blood gas sample – marrow will block the analyser.

APH (antepartum haemorrhage)

See also ‘Placenta praevia’ on page 271.

Placental abruption

1. Clinical features of major placental abruption are:
   - Abdominal pain and a tense, tender uterus.
   - Shock.
   - Vaginal bleeding in low proportion to the degree of shock.
   - Fetal distress or death.

2. Establish basic measures (see page 53).
3. Coagulation disorders are more common in this condition. You should request fibrinogen and FDPs specifically on the coagulation screen, and you should order two units of fresh frozen plasma immediately on making the diagnosis of major placental abruption. Do not wait for haematological evidence of coagulopathy.

4. Aim to keep the fibrinogen level greater than 2 g L\(^{-1}\); levels less than this are a strong positive predictive factor for worse postpartum haemorrhage (see page 69).

5. DIC or consumption coagulopathy can occur in major abruption and initial coagulation studies must be repeated after 1-2 hours. Platelet transfusion may be required.

6. There is a high risk of postpartum haemorrhage following placental abruption and you should prevent this with a Syntocinon infusion (see page 216).

**PPH (postpartum haemorrhage)**

1. Unexplained tachycardia during caesarean section, even when the patient is awake with a reasonable blood pressure, is an ominous sign that you must act upon. Check and check again whether the patient could be bleeding. During any caesarean section, observe the bleeding and query the uterine tone.

2. Establish basic measures (see page 53).

3. The most common cause is uterine atony. Other causes that you should consider in discussion with the obstetrician are genital tract trauma and retained placenta or other mechanical obstruction to contraction. Less common causes are endometritis or intrauterine sepsis, coagulopathies, and uterine inversion. The obstetricians use the four Ts mnemonic – Tone, Trauma, Tissue and Thrombin. Remember the effect of Temperature.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tone: uterine atony.</td>
<td>70%</td>
</tr>
</tbody>
</table>
Obstetric haemorrhage

Trauma e.g. cervical or vaginal tears, ruptured uterus from previous scars, extension of uterine angles at time of caesarean section. 20%
Retained tissue e.g. placenta, membranes. 10%
Coagulopathy – often a late cause. 1%

4. Determine with the obstetrician whether Syntocinon (by bolus or infusion) is indicated, and administer it. See below for further drug treatment.

5. Examination under general anaesthesis is indicated by:
   • Failure of uterine contraction with obstetrical methods.
   • Persistent bleeding with uterine contraction.

6. Consider critical care for the postoperative management of patients who have had hysterectomy performed to control haemorrhage. However, this is not always indicated. With prompt and effective prevention of shock (maintenance of arterial pH due to good resuscitation) haemorrhages in excess of ten litres can readily be managed on the labour ward.

Pharmacological treatment of uterine atony

Syntometrine (Syntocinon 5 units with ergometrine 500 mcg) is the standard prophylaxis, given intramuscularly at the delivery of the infant. This is used for most vaginal deliveries although it is possible that it may be replaced by Syntocinon as a result of the 2011 maternal mortality report [20] and 2016 RCOG guidelines [21]. Syntocinon causes significantly less nausea and hypertension.

As the anaesthetist you hold primary responsibility for the following measures.
Obstetric haemorrhage

- **Syntocinon bolus and infusion**
  - **Good tone?**
    - **Yes**
    - **No**
      - **Recheck all drug use; repeat Syntocinon bolus carefully and consider increasing infusion rate**
        - **Good tone?**
          - **Yes**
          - **No**
            - **Ergometrine; repeat as necessary**
              - **Good tone?**
                - **Yes**
                - **No**
                  - **Carboprost; consider escalating case with senior staff; offer misoprostol; specific handover to midwife**

- **Specific handover to midwife**
  - **Offer misoprostol**
**Obstetric haemorrhage**

**Syntocinon** should be given by intravenous bolus (5 units; dilute 10 units into 10 mL with saline 0.9%), usually repeated once, (except as below). Follow this with an infusion of 20 units Syntocinon in 50 mL saline starting at 15 mL h⁻¹.

Intravenous Syntocinon, especially but not only in doses above 5 units, can cause hypotension and circulatory collapse if given in the presence of hypovolaemia or any form of shock, through marked reduction in systemic vascular resistance. This drug must be given by infusion at the slowest effective rate in cardiac disease or pulmonary oedema. Oxytocics are however necessary to reduce blood loss. In these cases and if there is no treatment plan in the notes, we suggest making up the standard postpartum infusion, omitting the bolus dose altogether and commencing the infusion at 60 mL h⁻¹ (0.4 i.u. min⁻¹) for a maximum of ten minutes and keep in constant communication with the obstetrician about the state of uterine contraction. Reduce the dose as soon as possible. All such cases must be discussed with a consultant.

**Ergometrine** 50-100 mcg by intravenous injection (make up 500 mcg to 10 mL with saline; give 1-2 mL at a time repeated as necessary). Intravenous ergometrine will act within 40 seconds; when given intramuscularly (500 mcg) it acts within about seven minutes. Ergometrine is a hypertensive agent and is relatively contraindicated in pre-eclampsia and other hypertensive conditions. This drug is best avoided in severe pre-eclampsia and many cases of cardiac disease; if haemorrhage control is needed nonetheless then use arterial line monitoring and doses of 25-50 mcg.

**Carboprost** (Hemabate, or prostaglandin F₂α) is indicated for uterine atony unresponsive to ergometrine or Syntocinon. It is given as an intramuscular dose of 250 mcg repeated up to every 15 minutes in severe cases (no more than eight doses or 2000 mcg). Side effects include nausea, vomiting, flushing, bronchospasm, hypoxia (abnormal ventilation-perfusion ratio and intrapulmonary shunt fraction) and hypertension. Excessive dosage may cause uterine rupture. 85% of patients respond to the first dose.
Carboprost is kept in the obstetric theatre refrigerator. Carboprost must not be given intravenously. Intravenous administration is associated with severe bronchospasm, systemic and pulmonary hypertension. Intramyometrial injection is not licensed but can be used in severe cases such as first exposure of the uterus at laparotomy for postpartum haemorrhage following failure of pharmacological management; the dose is 500 mcg [21]. Observe the patient carefully: it is possible for an intramyometrial dose rapidly to enter the systemic circulation via uterine venous plexuses.

Maternal asthma is a strong relative contraindication. It may be used with caution in asthmatic patients, weighing the severity of asthma against the urgency of the need to increase uterine tone. Seek senior help and advice.

Misoprostol (prostaglandin E₁) may be given rectally at a dose of 1000 mcg [21]. Offer this when the surgeon checks the birth canal. It is often used when the patient has had some atony requiring higher dose Syntocinon or another uterotonic agent, to maintain tone in the postnatal period. This will probably cause gastrointestinal symptoms such as diarrhoea.

**Use of red blood cells**

| The blood bank phone number is 25322 (bleep 2169). Use 25398 for emergency haemorrhage. |
| Seek the advice of a consultant haematologist in coagulopathy or massive haemorrhage. |
| Do not attempt to manage massive haemorrhage on your own. Discuss potential cases with a senior colleague and call for help if it happens. |
| Send samples (FBC and coagulation screen and fibrinogen) every two hours or more often as indicated. |
| If available, use TEG to guide therapy. |

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Obstetric haemorrhage

Emergency O Rh negative blood

Several units are maintained in the blood fridge in labour ward theatres. You must inform blood bank if these units are used, using the form kept with the unit. Switch to group-specific blood as soon as is feasible [21].

Electronic issue of blood (EIB)

Blood issued electronically will be in theatre swiftly. To be suitable for electronic issue of blood, a patient has to fulfil all the following criteria:

1. Two serum samples processed by blood bank, at least one within the previous three days for patients in the third trimester. The antenatal screen (listed as FAN or BAN on CRRS) can be used as a reference sample but the current sample must be a valid ‘group and screen’ (GA) tested here at UHCW within the last three days. The two samples must have been taken by different practitioners.

2. Both samples to agree with each other on blood group.

3. Antibody screen negative on both samples.

In practice, if a recent GA (group and screen) sample and a BAN or second GA sample are on CRRS without an antibody flag then the patient is suitable for EIB. However, this is dependent on their recent history of any blood transfusion.

Rhesus negative women will very likely have received prophylactic anti-D. This makes them PD-antibody positive and currently unable to have blood electronically issued.

Red blood cells – indications for transfusion

Try to maintain circulating haemoglobin with cell salvage if possible. If it is not, then consider allogeneic blood transfusion.

You must check every transfused unit of blood against the patient’s verified wristband, and verbally if she is conscious. There is detailed advice about managing blood transfusions in the Anaesthetists Handbook. You must make a record of a valid, defined and justifiable indication for every blood transfusion.
There are no firm criteria for initiating red cell transfusion. Base your decision to provide blood transfusion on both clinical and haematological assessment [21]. The following guideline is adapted from SIGN [22] and the BSH guidelines [23]. It was drawn up for elective surgery in non-pregnant patients but we recommend it for obstetric haemorrhage.

- Transfusion is unlikely to be justified at haemoglobin levels above 100 g L\(^{-1}\).
- Transfusion is almost always required at haemoglobin levels below 70 g L\(^{-1}\).
- Patients with cardiovascular disease, or those expected to have covert cardiovascular disease are likely to benefit from transfusion when their haemoglobin level falls below 90 g L\(^{-1}\).
- Transfusion at levels between 70 g L\(^{-1}\) and 100 g L\(^{-1}\) is at the discretion of the clinician, and should take into account any postoperative symptoms such as tachycardia, dyspnœa and failure to mobilise. You should also consider the preoperative haemoglobin level and all other relevant factors.
- Red cells also contribute to haemostasis by their effect on platelet margination and function. The optimal haematocrit to prevent coagulopathy is unknown, but sufficient red cells will be required to sustain haemostasis in patients with massive blood loss.
- Red cells also contribute to haemostasis by their effect on platelet margination and function. The optimal haematocrit to prevent coagulopathy is unknown, but experimental evidence suggests that a relatively high haematocrit, possibly 35%, may be required to sustain haemostasis in patients with massive blood loss.

Remember that these patients may need critical care and will need postpartum iron therapy.

If there is a central venous pressure line in place, send a mixed venous blood sample to the blood gas machine. If S\(_{\text{vO}_2}\) is less than 70% even with tolerable haemoglobin levels, transfuse red cells to improve oxygen delivery.
Obstetric haemorrhage

The blood gas machine will measure lactate: use this with pH for assessing the adequacy of resuscitation.

Maintain continuous observation of haemorrhagic losses and communication with the operating surgeon, and transfuse in anticipation.

A further cross-match sample is not required after eight units of blood.

ICS (intraoperative cell salvage)

See page 229 for the main chapter on ICS.

ICS can be used in the management of obstetric haemorrhage. While it is usually indicated for most caesarean sections, it may be possible to set it up when haemorrhage starts. It can be set up in less than five minutes and is indicated in the emergency setting if bleeding continues and you expect there to be more to salvage and process.

Always send for senior assistance if you are in this position – the patient is haemorrhaging.

Check with the ODP and consider sending for another ODP.

In ongoing massive haemorrhage, do not use the reinfusion filter. The filter will slow reinfusion down so far that it cannot be used for reinfusion as part of intraoperative red cell therapy. In this case the balance of risk favours rapid return of salvaged red cells.

Use of haemostatic blood components

Postpartum haemorrhage associated with atony or trauma is unlikely to be associated with haemostatic impairment unless the diagnosis is delayed [24]. Be careful with excessive use of FFP.

Platelets

Keep the platelet level above $75 \times 10^9 \text{ L}^{-1}$ in acutely bleeding patients [21,25]. Anticipate need and order early for when required if there is a rapidly falling count or repeat sample, or if a patient blood volume has been replaced (approximately 90 ml kg$^{-1}$). Platelets may need to come from Birmingham. Liaise with the blood bank to ensure that two pools of
platelets are available locally and send for them if not; a decision to transfuse can be taken later.

Empirical treatment may be indicated in massive transfusion. Give one pool of platelets with each five units of red blood cells. Liaise with the consultant haematologist.

**FFP (fresh frozen plasma)**

Aim for prothrombin time less than 20 seconds and activated partial thromboplastin time ratio less than 1.5. Above this level there will be increased surgical bleeding to complicate PPH.

Order FFP when you declare massive obstetric haemorrhage and anticipate transfusing more than four units of allogeneic blood or 1200 mL salvaged blood. Allow up to forty minutes defrosting and transport time. FFP is a high-volume infusion at 250 mL per unit.

Defrosted FFP can be returned to blood bank so long as it has stayed within the cool chain, and can then be issued to other patients (within 24 hours of defrosting).

If no haemostatic results are available and bleeding is continuing, then, after four units of red blood cells, administer FFP at a dose of 12-15 mL kg⁻¹ until haemostatic test results are known [21]. Also consider this for conditions with a suspected coagulopathy, such as placental abruption or amniotic fluid embolism, or where detection of PPH has been delayed.

In class 4 haemorrhages above 50% and with relentless bleeding, transfusing plasma in a 1:1 ratio with red cells may give benefit.

**Fibrinogen and cryoprecipitate**

Fibrinogen is important in primary haemostasis through platelet activation and aggregation, and in secondary haemostasis through fibrin polymerisation. Levels rise during the third trimester of pregnancy to twice those of non-pregnant levels. Fibrinogen deficiency develops early when concentrated red cells are used to replace lost whole blood. Low fibrinogen levels during operative surgery point to serious trouble. Levels below 2 g L⁻¹ are a strongly predictive of massive PPH, transfusion needs,
surgical intervention and the need for critical care [26,27,28]. This work is compelling though it is unclear whether the low fibrinogen levels are a causative factor; no intervention studies are reported yet.

Aim for fibrinogen levels greater than 2 g L\(^{-1}\) during ongoing PPH [21]. Ensure that you request fibrinogen levels with any coagulation screen. Allow forty minutes defrosting and transport time. Cryoprecipitate has less volume than FFP.

The adult dose is two pools (each pool containing five units, 100-200 mL per bag).

If bleeding has progressed so that the uterus is a large bag of blood, it is likely that the uterine contents will be a large fibrin clot. In this case administer four pools (twenty units) of cryoprecipitate empirically without waiting for the coagulation screen results.

**Haemostatic failure**

If severe pre-eclampsia, consumption coagulopathy or amniotic fluid embolism (AFE) is suspected or there seems to be widespread haemostatic failure not responding to FFP, give a pool of cryoprecipitate followed by one adult therapeutic dose of platelets if bleeding persists. Suspected AFE will require larger volumes of cryoprecipitate. Obtain fresh coagulation results and haematology advice.

Consider systemic haemostatic agents as below.

| Hypothermia causes and will worsen coagulopathy. |

**Perioperative systemic haemostatic agents**

**Tranexamic acid (Cyklokapron)**

This is an antifibrinolytic agent which stabilises the formation of blood clots, by inhibiting the conversion of plasminogen to plasmin. It is indicated in massive obstetric haemorrhage as a first line measure.

The dose is 15 mg kg\(^{-1}\) repeated every four hours as necessary – in practice a single slow intravenous injection of 1 g (2 × 5 mL) is a suitable dose when estimated blood loss exceeds 1000 mL [25]. It can be repeated
immediately if bleeding is out of control. Start a postoperative infusion of 1 g over eight hours.

Postoperative thromboprophylaxis with enoxaparin should be established in order to prevent further fibrin deposition and an aggravated prothrombotic state. Discuss this with a haematologist.

Recombinant activated Factor VII (rFVIIa; NovoSeven)

If considering the use of rFVIIa you must ensure that consultants in obstetrics, anaesthetics and haematology are aware of the case. See [29]. RCOG recommends use only as part of a clinical trial [21].

This drug was thought to show great promise but trial evidence has not emerged to support its place in clinical guidelines. There have been reports of non-responders and thromboembolic complications, predominantly arterial such as myocardial infarction and cerebral thrombosis. It is unlikely to be of use and decisive surgical action may be more important.

Requirements for rFVIIa to work as desired include normothermia, correction of acidosis, and near-normal levels of platelets, calcium and fibrinogen. Correcting these may well eliminate any need for further measures such as rFVIIa.

The mechanism of action of rFVIIa suggests enhancement of haemostasis limited to the site of injury without systemic activation of the coagulation cascade. In multiply transfused coagulopathic patients it may stop diffuse bleeding. One dose is a minimum of 90 mcg kg\(^{-1}\).

rFVIIa is used to control unresponsive life-threatening bleeding, when all other measures have failed, pH and temperature are near the normal range, fibrinogen greater than 2 g L\(^{-1}\), calcium is normal and the platelet level is above 40 \(\times 10^9\) L\(^{-1}\). There is no specific indication on the coagulation screen. It might be considered when blood loss has reached 90 mL kg\(^{-1}\) (approximately seven litres) or general bleeding is out of control, or when emergency hysterectomy is considered. rFVIIa will cost approximately £4,000 per dose.
**Obstetric haemorrhage**

**Actions when haemostasis is not secure**

You should make your best efforts to correct known or suspected coagulopathy, acidosis and hypothermia, to maintain an adequate circulation delivering platelets and fibrinogen to the site of bleeding.

<table>
<thead>
<tr>
<th>Surgical actions</th>
<th>Anaesthetic actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Call consultant to attend.</td>
<td>1. Call consultant and labour ward coordinator to attend.</td>
</tr>
<tr>
<td>2. Inspect and repair vagina and cervix.</td>
<td>2. Restore blood volume and oxygen-carrying capacity to keep arterial pH above 7.00.</td>
</tr>
<tr>
<td>3. Check uterine cavity for rupture.</td>
<td>3. Use uterotonic – give oxytocin, ergometrine and carboprost as indicated.</td>
</tr>
<tr>
<td>5. Tamponade uterine bleeding: uterine packing, Bakri balloon or brace suture as indicated.</td>
<td>5. Maintain core temperature above 35°C.</td>
</tr>
<tr>
<td>6. Surgical haemostasis should be attempted.</td>
<td>6. Check volatile dose and uterotonic again.</td>
</tr>
<tr>
<td></td>
<td>7. Treat coagulopathy if possible:</td>
</tr>
<tr>
<td></td>
<td>a. Keep platelet count above 75 x 10⁹ L⁻¹.</td>
</tr>
<tr>
<td></td>
<td>b. Keep prothrombin time below 16 seconds with FFP.</td>
</tr>
<tr>
<td></td>
<td>c. Keep fibrinogen level above 2 g L⁻¹ with cryoprecipitate.</td>
</tr>
</tbody>
</table>

**Aprotinin (Trasylol)**

The licence for the antifibrinolytic agent aprotinin was withdrawn and then reinstated in controversial circumstances [30]. It is presently
available for cardiothoracic surgery only. You should not use it unless under instruction from a consultant haematologist.

**Interventional radiology**

Bilateral placement of catheters into the internal iliac arteries, with perioperative balloon occlusion or transcatheter arterial embolisation has been used effectively to control massive obstetric haemorrhage.

In this procedure, a radiologist places catheters into the contralateral internal iliac arteries via the femoral arteries. Intravascular balloon inflation provides temporary control and it is possible to use foam embolisation for permanent control.

However, it is a prolonged procedure needing careful planning and taking place in the radiology department. It is very unlikely to be effectively employed in an acute situation if catheters are not already in place.

**Indications**

Perioperative balloon occlusion is indicated for a high risk of placenta accreta based on a history of previous caesarean section along with sonographic findings pointing to anterior placenta praevia [31]. This probabilistic approach does lead to a high incidence of unnecessary intervention. MRI imaging or transvaginal ultrasound should also be available to augment the diagnosis.

**Management**

Where a case is being planned, experience has shown that the catheter insertion is quite uncomfortable. The choice of anaesthesia for such a planned case may well be epidural followed by general anaesthesia. You should recommend placing the epidural before the femoral artery catheters.

The patient will need to have had a coagulation screen and renal function check (urea and creatinine) before the procedure – make sure this has been done within a week of the procedure if planning a case.

Liaise with the radiologist about timing and dose of any heparin they may wish to use in relation to catheter removal after the case.
**Obstetric haemorrhage**

Perioperative balloon occlusion is normally performed under angiographic confirmation. This will require that a portable image intensifier be in theatre.

It will not halt blood flow to the uterus, but can be expected to reduce pulse pressure distal to the occlusion, this reducing intraoperative blood loss. This may prevent hysterectomy, or reduce blood flow into the operative field and reduce the incidence of complications of emergency hysterectomy.

**Complications**

Thromboembolism of the iliac arteries, bladder and rectal wall necrosis and cauda equina syndrome can result.

Catheter placement can result in uteroplacental insufficiency and fetal compromise [32] – there should be fetal monitoring throughout the procedure. Take terbutaline to fluoroscopy in case of fetal distress due to contractions (250 mcg may be given subcutaneously).

**Women who refuse blood transfusion**

Refusal of consent can be on religious grounds (Jehovah’s Witness, Rastafarian etc.) or can be because of personal beliefs. You may be asked to speak with a woman who is considering declining blood transfusion. This may be done because of our expertise in running the red cell salvage programme, which is valued by the obstetricians and mothers alike. Give adequate time to discuss these matters with the woman and record the disclaimer, including the various types of blood components available and whether they are acceptable to the patient. Refer to the current hospital guideline on refusal of consent for transfusion and complete the paperwork as far in advance as possible.

Red cell salvage may be suitable – see page 231.

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