Chapter J

Postpartum Hemorrhage

Ann Evensen, MD
Janice Anderson, MD
Published February 2015

OBJECTIVES

After completing this chapter, participants will be able to:

1. List the important causes of postpartum hemorrhage.
2. Describe methods for preventing postpartum hemorrhage.
3. Discuss the need for early recognition and quick response to postpartum hemorrhage.
4. Describe the treatment of postpartum hemorrhage.

INTRODUCTION

Postpartum hemorrhage (PPH) is excessive bleeding after delivery of the fetus and may occur before or after delivery of the placenta. Clinicians must learn to recognize excessive bleeding and intervene, preferably before other signs and symptoms of PPH develop (see Table 1).

Table 1. **Signs and Symptoms of Postpartum Hemorrhage**

Symptoms	Signs
Lightheadedness	Bleeding over 500 mL with vaginal delivery
Weakness	Hypotension
Palpitations	Tachycardia
Restlessness	Diaphoresis
Confusion	Syncope
Air hunger	Pallor
	Oliguria
	Hypoxia

DEFINITION, EPIDEMIOLOGY, AND SIGNIFICANCE

Postpartum hemorrhage (PPH) is traditionally defined as the loss of more than 500 milliliters of blood following vaginal delivery or more than 1000 milliliters following cesarean delivery.[1] PPH is considered severe when blood loss exceeds 1000 milliliters after vaginal delivery or results in signs or symptoms of hemodynamic instability.[1] However, the definition of PPH is debated as more recent studies have shown that the median blood loss at spontaneous vaginal delivery exceeds 500 milliliters.[2] Postpartum hemorrhage can be classified as primary, which occurs within 24 hours of delivery, or secondary, which occurs 24 hours to 12 weeks postpartum.[3] Primary PPH is more common than secondary PPH.

Even with appropriate management, approximately five percent of obstetric patients will experience PPH, and one percent of vaginal deliveries will result in severe PPH.[4-7] PPH is the number

one cause of maternal mortality in developing countries and is the cause of 25 percent of maternal deaths worldwide.[8] It is a common maternal morbidity in high resource countries and is trending upward.[6]

Potential sequelae of PPH include orthostatic hypotension, anemia and fatigue which can make breastfeeding and maternal care of the newborn more difficult.[9] Postpartum hemorrhage may increase the risk of postpartum depression and acute stress reactions.[9,10] Transfusion may be necessary and carries associated risks including infection and transfusion reaction.[11] In the most severe cases, dilutional coagulopathy should be anticipated. Hemorrhagic shock may lead to Sheehan's Syndrome (posterior pituitary ischemia with delay or failure of lactation), occult myocardial ischemia, or death.[11,12]

RISK FACTORS FOR POSTPARTUM HEMORRHAGE

Risk factors include antepartum and intrapartum conditions as listed in Table 2. However, 20 percent of patients who develop postpartum hemorrhage have no risk factors, so providers must be prepared to treat it at every delivery.[4]

Table 2. **Risk Factors for Postpartum Hemorrhage**

Antepartum Risk Factors	Labor Risk Factors	Surgical Interventions
• History of PPH (estimated 10 percent recurrence with subsequent deliveries)[1] • Nulliparity • Grand multiparity (> five deliveries) • Coagulopathy (congenital or acquired including use of medications such as aspirin or heparin) • Abnormal placentation • Age > 30 years[7,13] • Anemia • Overdistension of the uterus – Multiple gestation – Polyhydramnios – Fetal macrosomia	• Prolonged labor (first, second, and/or third stage) • Preeclampsia and related disorders • Fetal demise • Induction or augmentation • Use of magnesium sulfate • Chorioamnionitis	• Operative vaginal delivery • Cesarean section • Episiotomy • REFS [3,5,7,13]

PREVENTION

The best preventive strategy is active management of the third stage of labor (AMTSL).[14] This includes 1) administering oxytocin with, or soon after, the delivery of the anterior shoulder and 2) cutting the cord after a delay of one to three minutes, 3) controlled cord traction to deliver the placenta, and 4) uterine massage after delivery of the placenta.[14,15] To perform controlled cord traction, grasp the cord with one hand and gently apply traction while simultaneously applying subrapubic (NOT fundal) pressure with the other hand (called the "Brandt maneuver").

Administration of a uterotonic drug is the most important step in reducing PPH.[16] The benefits of the other steps are less clear.[17] Earlier definitions of AMTSL did not include transabdominal uterine massage after placental delivery, but it is a reasonable approach and is now included in some AMTSL protocols.[15,18,19] In addition, initial AMTSL protocols included cutting the umbilical cord immediately after delivery (less than 30 seconds). However, trials have shown that a delay in cord clamping of one to three minutes has benefits to the newborn without an increase in PPH or neonatal morbidity.[20] These benefits include a decrease in anemia in pre-term and term infants and decrease in intraventricular hemorrhage in the very pre-term newborn.[21,22]

Active management decreases severe PPH, reduces the risk of postpartum anemia, and shortens the third stage of labor with no significant increase in cases of retained placenta.[14,23,24] A reduction in the incidence of PPH also occurs if oxytocin is given after placental delivery.[23] AMTSL is recommended by the American College of Obstetricians and Gynecologists (ACOG), International Federation of Gynecologists and Obstetricians (FIGO), International Confederation of Midwives (ICM), and the World Health Organization (WHO).[1,25] Hospital guidelines that encourage the use of active management result in significant reduction in the incidence of severe PPH.[26]

Oxytocin (IM or IV) is the preferred uterotonic agent for preventing PPH because it is at least as effective and has fewer side effects than the ergot alkaloids and prostaglandins.[16,23] There is a long-held view that intravenous administration of oxytocin increases the risk of transient hypotension, but a randomized controlled trial found that a 10-unit IV bolus in patients delivering vaginally did not cause significant hypotension.[27] As many women in high resource settings have intravenous access, IV oxytocin is commonly used for AMTSL.[28] A reasonable dose would be 5 to 10 units of oxytocin given as a bolus over one to two minutes.[28] This dosing regimen requires oxytocin in a higher concentration than that used for labor induction or augmentation (for example, 10 units in 50 to 100 mL crystalloid bolus or 30 units in 500 mL crystalloid given as a 100 to 150 mL bolus followed by a maintenance infusion).

Misoprostol has been evaluated for prevention of PPH because of its advantages in resource-poor areas: it is inexpensive, heat and light stable, and can be administered without the use of syringes.[29-31] Misoprostol (oral or sublingual) compared to placebo reduces severe PPH and blood transfusion.[16,29-31] However, oxytocin remains the drug of choice for the prevention of PPH when available. In a meta-analysis of 29,797 women in 17 trials, oral misoprostol compared to conventional injectable uterotonics showed increased risk of severe PPH [relative risk (RR) 1.33; 95 percent confidence interval (CI) 1.16 to 1.52] and use of additional uterotonics but with fewer blood transfusions (RR) 0.84; 95 percent CI 0.66 to 1.06; 15 trials, 28,213 women).[16] A randomized controlled trial of 652 women, which occurred after the meta-analysis, demonstrated superiority of powdered, sublingual misoprostol 400 mcg compared to intramuscular oxytocin 10 units (OR = 0.32; 95 percent CI 0.16 to 0.67) for the prevention of PPH.[29] As in other studies, misoprostol had a greater incidence of side effects including increased shivering and fever.[16,29] Misoprostol-related fever has a typical pattern: it is usually preceded by shivering, has an onset at less than 20 minutes postpartum, peaks at one to two hours, and spontaneously declines over three hours. One researcher recommended that women with this typical presentation of a postpartum fever after peripartum misoprostol are initially monitored with investigations and treatment only if the fever persists beyond three hours postpartum.[32]

At this time, misoprostol should be used for prevention of PPH only when oxytocin is not available. The World Health Organization lists misoprostol as an essential medication for preventing PPH, but it is not FDA-approved for this indication.[33] A reasonable dose is 600 micrograms orally.[29-31] More research is needed in this area to define the most effective regimens for preventing PPH, especially in low resource and pre-hospital settings.

In addition to oxytocin given at the time of delivery, complications of PPH can be reduced by specific strategies before, during, and after labor.

Antenatally, patients who are at high risk for invasive placenta (such as prior uterine surgery, placenta previa, or coagulopathy) should have a sonogram.[34,35] Women found to have invasive placenta and others at high risk of PPH should be delivered at a facility with blood bank, anesthesia, and surgical capabilities. All women should be screened for anemia and treated for reversible causes of anemia (e.g. iron deficiency, malaria). Women of African, Southeast Asian or Mediterranean descent should be offered screening for sickle cell or thalassemia by hemoglobin electrophoresis and complete blood count.[36] Risks and benefits of these interventions should be discussed with patients and their choices documented. Clinicians should identify Jehovah's Witnesses and other patients who refuse use of blood products.

Avoiding routine episiotomy, use of perineal warm compresses, and using a vacuum rather than forceps when assisted vaginal delivery is required may decrease the incidence of perineal trauma.[37-39] Oxytocin and second line uterotonics (e.g. methylergonovine [Methergine], misoprostol, carboprost) should be readily available in the delivery suite and operating room. Vital signs and lochia should be assessed frequently to detect slow but significant blood loss.

For patients at very high risk of PPH, "type and cross" packed red blood cells (PRBCs) and other blood products should be readily available in the delivery suite or operating room. Women with anemia should have aggressive prevention and treatment of PPH as complications may occur at smaller volumes of blood loss.

DIAGNOSIS AND MANAGEMENT

Preparation, early recognition, and quick response to excessive blood loss will reduce morbidity associated with both primary and secondary PPH. The diagnosis of PPH begins with recognition of excessive bleeding and methodical examination for its cause. The mnemonic, "The Four T's – Tone, Trauma, Tissue, and Thrombin" can be used to remember specific causes (Table 3).

Table 3. Mnemonic for the Specific Causes of PPH – The Four Ts

Four Ts	Specific Cause	Relative Frequency
Tone	Atonic uterus	70 percent
Trauma	Lacerations, hematomas, inversion, rupture	20 percent
Tissue	Retained tissue, invasive placenta	10 percent
Thrombin	Coagulopathies	1 percent

GENERAL APPROACH TO A WOMAN WITH POSTPARTUM HERMORRHAGE

Pregnant women have increased plasma volume and red blood cell mass.[3] In addition, they are typically healthy and can accommodate mild to moderate blood loss without having signs or symptoms such as orthostasis, hypotension, tachycardia, nausea, dyspnea, oliguria, or chest pain. Blood loss should be monitored in every delivery and action taken before the woman develops symptoms. Once excessive blood loss is suspected, treatment must be initiated quickly by progressing through the Four T's mnemonic (Tone, Trauma, Tissue, and Thrombin). As seen in Figure 1, many of the steps in diagnosis and management must be carried out simultaneously. Regardless of the suspected cause of bleeding, additional medical personnel will be needed to assist the delivering clinician. Assistants should be directed to start two large-bore intravenous lines (16 to 18 gauge). When bleeding occurs prior to placental delivery, attention is directed to its removal and inspection. If there is a delay in placental delivery or it is not intact, manual removal may be required. Difficulty locating a plane between the placenta and the uterus may signify invasive placenta.

After delivery of the placenta, vaginal bleeding will most often (70 percent) be due to uterine atony. The first maneuver to reduce bleeding is uterine massage. Oxytocin can be given next, via the (equally effective) intramuscular or intravenous route.[1,28] If uterine tone does not improve with compression, massage, and oxytocin, a second uterotonic can be administered. During this time, the genital tract can be explored and lacerations repaired.

If vaginal bleeding persists after uterine atony has been treated and no lacerations or hematomas have been recognized, it is useful to explore the uterus (preferably after analgesia) to determine if retained placental fragments are responsible for continued bleeding. Uterine exploration will also allow detection of ruptured or partial uterine inversion. Hypotension or shock out of proportion to the amount of blood loss raises the suspicion for concealed hematomas, uterine rupture, or uterine inversion. Anaphylaxis, sepsis, and amniotic fluid or pulmonary embolism should also be considered. Persistent oozing or lack of clotting may signal a coagulopathy, sometimes caused by the hemorrhage itself.

Blood loss greater than 1500 milliliters requires immediate resuscitation measures using an interdisciplinary team approach, including anesthesia, laboratory, nursing, surgery, and blood bank staff. As part of the initial management of this emergency, clinicians should perform a *primary maternal survey and institute care to support circulation, airway, and breathing (the 'C-A-B'):*

1) Open the airway and give supplemental oxygen to maintain oxygen saturation of greater than 95 percent.
2) Ventilate the patient if needed, with 100 percent oxygen.
3) Provide intravenous fluid and possibly blood replacement by starting two large bore IV's with normal saline or other crystalloid fluids. Elevating the foot of the bed or having an assistant elevate the patient's legs will improve venous return and raise the patient's blood pressure.

After the primary maternal survey, obtain stat labs (type and cross, complete blood count, coagulation studies, and hold a red top for clot evaluation) if not already done when intravenous access is obtained. Place a Foley catheter to empty the bladder and monitor urine output. Heart rate and blood pressure should be monitored closely and times of relevant events should be documented. While vital sign changes may be delayed even with significant hemorrhage, the earliest to occur is tachycardia and narrowing pulse pressure. It may be necessary to infuse O-negative blood while waiting for type-specific blood.

Institute a "massive transfusion protocol," if available, for any hemorrhage of greater than 1500 mls or ongoing blood-loss that is symptomatic.[40,41] Research with critically injured trauma victims has shown improved survival with use of massive transfusion protocols that recommend infusion of fresh frozen plasma (FFP) and platelets whenever large numbers of PRBCs are needed. Typical massive transfusion protocol use ratios of four to six units of FFP and one unit of platelets for every six units of PRBCs without waiting for laboratory results to document coagulopathy.[42,43] Dilutional coagulopathy may still occur with use of these protocols, so coagulation studies and platelet counts should be checked frequently and deficiencies corrected with additional FFP, platelets, and/or cryoprecipitate. Intractable hemorrhage may require uterine packing (plain gauze or soaked with vasopressin, chitosan or carboprost), placement of an intrauterine tamponade device (see description below), angiographic embolization, or hemostatic drugs such as recombinant factor VIIa.[44-46] Compression of the aorta or the use of anti-shock garments can be done as a temporizing measure.[44,47] Surgery may be required (e.g., B-lynch procedure [Figure 3], hemostatic multiple square suturing, surgical ligation of arteries, or hysterectomy).[1,42] In the setting of continued hemorrhage despite use of bimanual massage, uterotonics and other surgical methods, a plan for rapid hysterectomy must be initiated as continued attempts at uterine conservation may increase the risk of maternal mortality.

UTERINE TAMPONADE DEVICES

Uterine tamponade devices (Bakri™, ebb™, and BT Cath® balloons) can be used to limit uterine bleeding while definitive treatment is arranged and/or while patient is transported to a facility with more advanced surgical capabilities. A uterine tamponade balloon is placed through the cervix (after vaginal delivery) or through the abdominal and uterine incisions (after cesarean section or at the time of uterine surgery to treat recalcitrant postpartum hemorrhage). A uterine tamponade balloon works by pressing against the hemorrhaging endometrial surface with a force that exceeds the uterine arterial and venous blood pressure. Uterine tamponade balloons are contraindicated in cases of allergy to the balloon material (latex, rubber), genital tract infection, cervical cancer, pregnancy, anomalies that distort the uterine cavity (e.g. large leiomyoma, congenital anomalies) and in situations where other treatment (e.g., arterial embolization, surgical exploration, hysterectomy) is needed. Studies of uterine tamponade balloons have been done with case series and their use is recommended in consensus guidelines.[33,45,48,49] The potential danger of postpartum hemorrhage makes the design of an RCT to evaluate tamponade balloons very unlikely. Manufacturers of uterine tamponade balloons have published instructions for safe use of their devices:

Bakri™ balloon: https://www.cookmedical.com/product/-/catalog/bakri-postpartum-balloon?ds=wh_sos_webds

ebb™ Balloon: http://www.bmmedical.co.uk/products/obstetrics/ebb/

BT Cath® Balloon: http://www.utahmed.com/btcath.htm

Clinicians should be familiar with the device that is available to them locally. Because the balloon is a temporary device and may fail or require a definitive treatment such as a B-lynch uterine suture or hysterectomy, a surgeon should be notified at the time of placement.

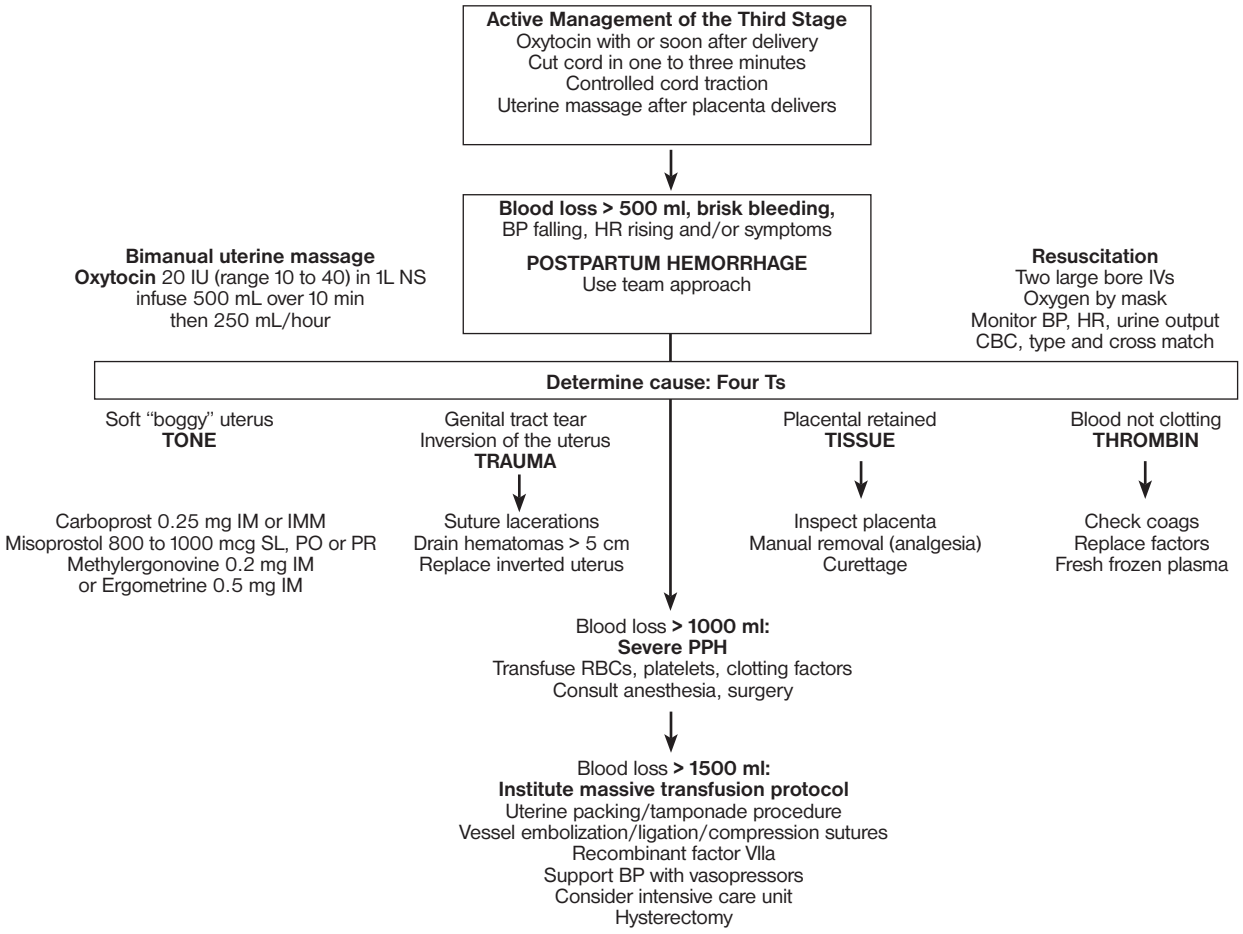
In secondary PPH (24 hours to six weeks after delivery), atony is still the most likely cause of bleeding.

Bleeding may occur at a slow rate, obscuring the overall volume of blood loss. Endometritis may complicate diagnosis and management. Pelvic ultrasound or Doppler studies may be used, but nondiagnostic findings are common. Careful curettage may be needed to remove retained tissue.[1]

Please see the ALSO® Chapter on Maternal Resuscitation for a general response to hemorrhage and related emergencies.

CAUSE-SPECIFIC APPROACH TO POSTPARTUM HEMORRHAGE

Figure 1. "The Four Ts" and Management of PPH



Many of the steps involved in diagnosing and treating PPH can be undertaken simultaneously.

Abbreviations: BP = blood pressure, cm = centimeter, HR= heart rate, IM = intramuscularly, IMM = intramyometrially, IU = international units, mL= milliliters, min = minutes, mg = milligrams, NS = normal saline, PO= by mouth, PR= per rectum, RBCs = red blood cells, SL=sublingually, coags = coagulation screen: platelet count, prothrombin time (INR), partial thromboplastin time, fibrinogen level, and fibrin split products (d-dimer).

Figure 2. **Transcervical Placement of Bakri Balloon Catheter for Tamponade of Uterine Hemorrhage**

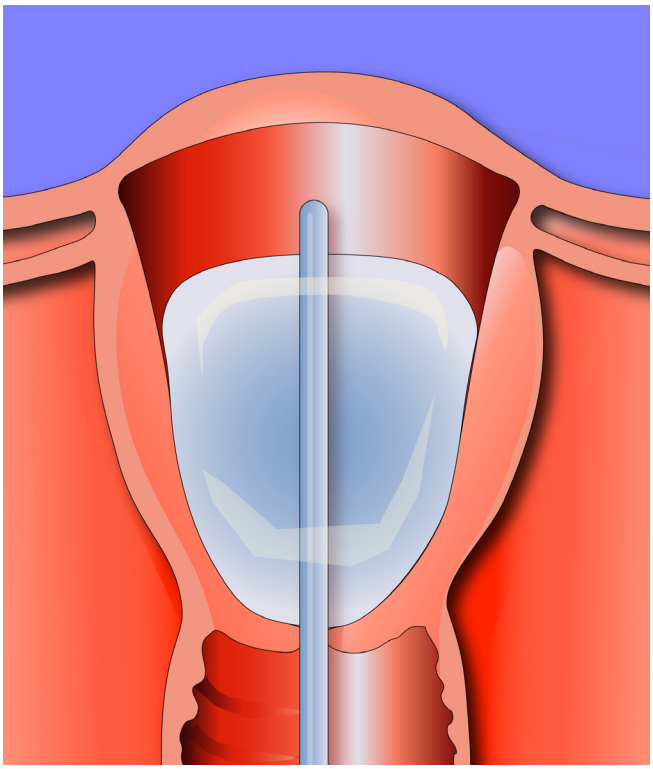
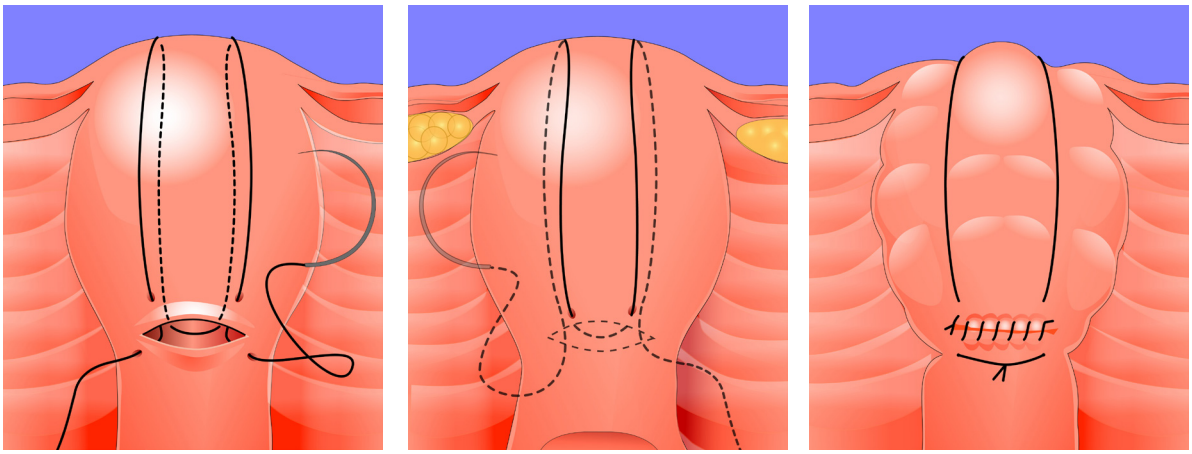


Figure 3. **B-Lynch Suture of Uterus for Severe Hemorrhage**



(a) Anterior View (b) Posterior View (c) Anterior View

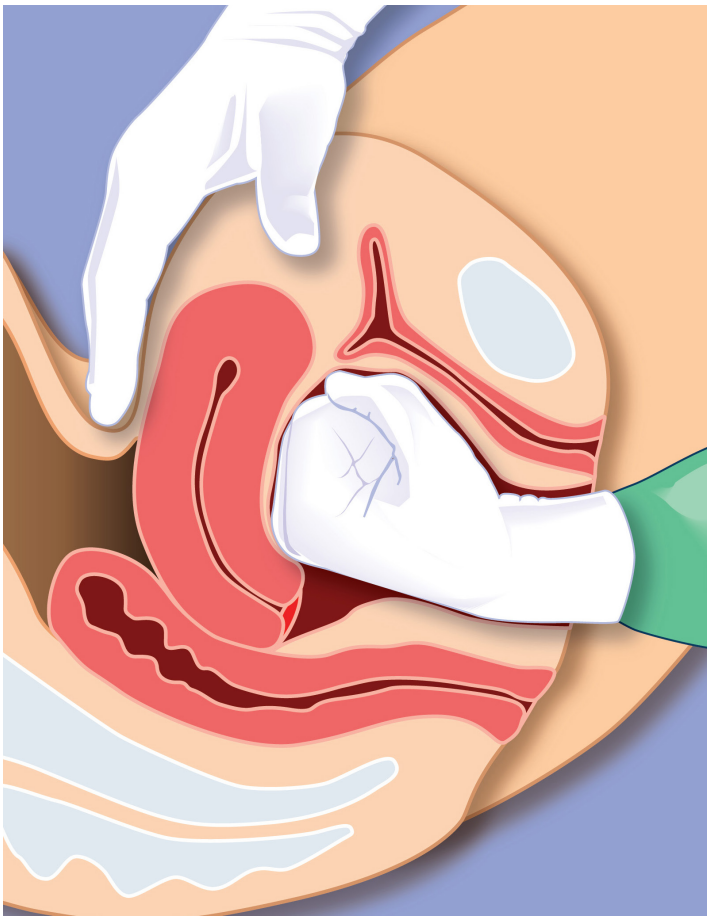
TONE

Uterine atony is the most common cause of PPH.[50] Because hemostasis following placental separation depends on myometrial contraction, transabdominal massage is recommended following delivery of the placenta in every delivery.[19] Atony unresponsive to transabdominal massage is treated initially by bimanual uterine massage while awaiting drugs that promote contraction of the uterus.

Uterine Massage

The appropriate response to a soft, "boggy" uterus and brisk flow of blood from the vagina after delivery of the placenta is bimanual uterine massage. To perform bimanual massage, the clinician uses one hand over the lower abdomen to massage the uterine fundus and one hand in the vaginal vault to massage the lower uterine segment. The position of the clinician's hands with respect to the uterus depends on the position of the uterus and the patient's body habitus. Figure 4 shows an anteverted uterus with the clinician's hand on the abdomen massaging the posterior aspect of the uterus. Two or more fingers of the vaginal hand are typically used for bimanual massage. Using the entire vaginal hand or fist to compress the uterus may be necessary for severe, persistent atony.

Figure 4. **Bimanual massage for uterine atony**



Uterotonic Agents

Uterotonic agents include oxytocin (Pitocin®, Syntocinon®), prostaglandins, and ergot alkaloids (Table 4). Uterotonic agents stimulate the myometrium to contract, constricting spiral arteries and decreasing blood flow through the uterus. Oxytocin is an effective first line treatment for PPH.[1] Oxytocin 20 to 40 units can be added to one liter of normal saline. An initial 500 ml (10 to 20 units of oxytocin) can be infused over 10 minutes without complications. Following this initial infusion, the oxytocin solution can be infused intravenously at 250 ml per hour. If atonic hemorrhage continues, the rate of infusion or oxytocin concentration may be increased (e.g. 40 to 80 units of oxytocin in one liter of normal saline).[48]

If oxytocin alone is insufficient to improve uterine atony and hemorrhage, the choice of second-line agent should be based upon patient factors (such as the presence of hypertension or asthma) and local maternity care practices. Methylergonovine (Methergine®) and ergometrine (Ergonovine®, not available in the U.S.) are ergot alkaloids that stimulate uterine muscle contraction.[50] A typical dose is 0.2 mg IM.[1,48,50] It can be repeated every two to four hours. Because ergot alkaloids agents cause vasoconstriction and raise blood pressure, they are contraindicated in women with preeclampsia, gestational hypertension, or chronic hypertension. Other adverse effects include nausea and vomiting. They should not be used in patients with HIV taking protease inhibitors. Protease inhibitors increase circulating levels of ergots; this increases their potential for side effects including arteriolar spasm and stroke.[51]

Prostaglandins such as 15-methyl prostaglandin F-2a (carboprost, Hemabate®) and misoprostol (Cytotec®) are strong uterotonics and can be used when adequate tone is not achieved with oxytocin .[16]

Carboprost is given IM in a dose of 0.25 mg, and can be repeated every 15 minutes for a total dose of 2 mg. Carboprost can be used at the same dose injected into the myometrium, typically during cesarean section or a postpartum surgical procedure to treat severe PPH. Carboprost has been shown to control hemorrhage in up to 87 percent of cases.[52] In cases where it was not effective, chorioamnionitis or other risk factors for hemorrhage were often present.[52] Hypersensitivity is the only absolute contraindication, but carboprost should usually be avoided in patients with asthma, hypertension, or significant cardiac or renal disease. Common side effects include nausea, vomiting, and diarrhea.[16]

Misoprostol (Cytotec®) can be administered by sublingual, oral, vaginal, or rectal routes, sometimes in combination.[29-31,53] Oral and sublingual dosing allow more rapid onset of action, but rectal dosing allows for longer duration of action and fewer gastrointestinal side effects. Acceptable dosages are 800 to 1000 mcg rectally or 600 to 800 mcg orally or sublingually.[1,31,33,50,54] Higher levels and larger doses are associated with more side effects including shivering, pyrexia, and diarrhea.[50] Even at low doses, misoprostol use is associated with more side effects than oxytocin use.[55] The use of misoprostol in addition to oxytocin does not significantly improve treatment of PPH as compared to oxytocin alone, especially if prophylactic oxytocin has already been given as part of the AMTSL.[33,55,56] Misoprostol has not been approved by the US Food and Drug Administration for the treatment of PPH. However, its use for PPH is recommended in the ACOG postpartum hemorrhage patient safety checklist.[48]

After initial stabilization of a patient with atony, ongoing monitoring is necessary, including checking of vital signs and assessment of any ongoing or recurrent bleeding. Methylergonovine (such as 0.2 mg by mouth every four hours for four doses) or oxytocin (such as 10 to 20 units in one liter of normal saline infused over four to six hours) can be given to maintain uterine tone.

Table 4. Medications Used for Prevention and Treatment of Postpartum Hemorrhage

Medication	Dose	Prevention	Treatment	Contraindications/ Cautions	Mechanism of Action	Side effects / Comments
First Line Agent:						
Oxytocin (Pitocin®, Syntocinon®)	Prevention: 10 IU IM or 5 to 10 IU IV bolus Treatment: 20 to 40 IU in 1000 ml NS. Infuse 500 ml over 10 minutes then 250 ml/hour	+	+	Overdose or prolonged use can cause water intoxication Possible hypotension with IV use following cesarean section	Stimulates the upper segment of the myometrium to contract rhythmically, constricting spiral arteries decreasing blood flow through the uterus.	Rare
Second Line Agent:						
Carboprost (Hemabate®) Prostaglandin F-2α analog	0.25 mg, IM or into myometrium repeated every 15 to 90 minutes for a total dose of 2 mg	-	+	Avoid in patients with asthma or significant renal, hepatic or cardiac disease	Improves uterine contractility by increasing the number of oxytocin receptors and causes vasoconstriction	Nausea, vomiting, and diarrhea
Methylergonovine (Methergine®) ——— Ergometrine (Ergonovine®) [not available in the US] May be combined with oxytocin as Syntometrine in United Kingdom and other nations	0.2 mg IM repeat every two to four hours ——— 0.5 mg IM Used IV in countries other than the US	- Not used in the US for prevention due to potential side effects	+	Avoid in hypertensive disorders of pregnancy including chronic hypertension Caution in patients with HIV taking protease inhibitors	Vasoconstriction and contracts smooth muscles upper and lower segments of the uterus tetanically	Nausea, vomiting, and increased B/P
Misoprostol (Cytotec®)* Prostaglandin E1 analog	Prevention: 600 mcg oral Treatment: 800 to 1000 mcg rectally, or 600 to 800 mcg sublingually or orally	+ Use only when oxytocin is not available	+	Caution in patients with cardiovascular disease	Generalized smooth muscle contraction	Nausea, vomiting, diarrhea, pyrexia, and shivering

Table References[1,14,16,30,31,33,50,52,54,57]

Table Footnotes:

Abbreviations: IM intramuscular, NS normal saline, BP blood pressure, AMTSL active management of third stage of labor.

**Misoprostol is not approved by the U.S. Food and Drug Administration for use in prevention or treatment of postpartum hemorrhage.*

TRAUMA

Lacerations and hematomas resulting from birth trauma can cause significant blood loss that can be lessened by hemostasis and timely repair. Sutures for hemostasis are placed if direct pressure does not stop the bleeding. Episiotomy increases blood loss as well as the risk of anal sphincter tears and should be avoided unless urgent delivery is necessary and the perineum is felt to be a limiting factor in achieving delivery.[13,38]

Hematomas can present as pain or as a change in vital signs out of proportion to the amount of blood loss observed. Patients with persistent signs of volume loss despite fluid replacement, or with large or enlarging hematomas, require incision and evacuation of the clot.[58] The involved area should be irrigated and the bleeding vessels ligated. Often a specific vessel cannot be identified and hemostatic figure of eight sutures are placed. Where there is diffuse oozing, a layered closure will help to secure hemostasis and eliminate dead space. Small, nonexpanding vaginal or vulvar hematomas (typically less than 4 cm) can be managed conservatively with ice packs, analgesia, and continued observation.[58]

Uterine Inversion

Uterine inversion is rare, occurring in about one in 2,500 deliveries.[59] Active management of the third stage, including the Brandt maneuver described above, does not appear to increase the incidence of uterine inversion.[59,60] Fundal, adherent, or invasive implantation of the placenta may lead to inversion; the role of fundal pressure and undue cord traction are uncertain.[61] The patient may show signs of shock (pallor, hypotension) without excess blood loss. Upon inspection, the inverted uterus may be in the vaginal vault or may protrude from the vagina, appearing as a bluish-gray mass that may not be readily identifiable as an inverted uterus. Roughly half the time, the placenta is still attached and it should be left in place until after reduction to limit hemorrhage.[59] If oxytocin is running, it should be stopped, and an attempt should be made to replace the uterus quickly. There are several methods for reduction. The Johnson method involves grasping the protruding fundus with palm of the hand, fingers directed toward the posterior fornix. The uterus is returned to position by lifting it up through the pelvis and into the abdomen with steady pressure towards the umbilicus.[59] Once the uterus is reverted, uterotonic agents should be given to promote uterine tone and prevent recurrence. If initial attempts to replace the uterus have failed or a cervical contraction ring develops, terbutaline, nitroglycerin, or general anesthesia may allow sufficient uterine relaxation for manipulation.[59]

Uterine Rupture

Although rare in an unscarred uterus, clinically significant uterine rupture complicates approximately 0.8 percent of trials of labor after cesarean (TOLAC) at term.[62] The risk is significantly increased in women with previous classical uterine incisions or a myomectomy that goes completely though the uterine wall; these women should not have a trial of labor and should be delivered by elective cesarean at 37 to 38 weeks.[63] Risk of uterine rupture is increased to a lesser extent with shorter intervals between pregnancies or a history of multiple prior cesarean sections, particularly with no previous vaginal delivery.[64,65] Compared to spontaneous labor, induction of a patient with a uterine scar increases the rate of uterine rupture to 1.0 to 1.5 percent.[62,64-66] The use of prostaglandins for cervical ripening appears to be associated with an increased risk of uterine rupture.[66] Although the evidence with regard to specific prostaglandins is limited, misoprostol (PGE1) is considered to be contraindicated while the use of the dinoprostone insert (Cervidil®, PGE2) remains controversial.[64,66]

The dinoprostone insert has the advantage of being easily removed if tachysytole or concerning fetal heart rate decelerations occur. Foley balloon may be considered for cervical ripening if induction is indicated in a patient desiring TOLAC.[64]

During labor, the first sign of uterine rupture is usually fetal heart rate changes such as fetal bradycardia.[64,67] Other signs or symptoms include: vaginal bleeding, abdominal tenderness, increasing abdominal girth, loss of uterine contractions, elevation of presenting fetal part, maternal tachycardia, or circulatory collapse.[64]

Uterine rupture can cause harm to both fetus and mother. Uterine rupture may require surgical repair of the defect, blood transfusion, or hysterectomy. Small, asymptomatic lower uterine segment defects incidentally noted on postpartum uterine exploration can be followed expectantly.[64] An Agency for Healthcare Research and Quality (AHRQ) sponsored summary about trial of labor (TOL) found no maternal deaths from uterine rupture among patients with term pregnancies. This report calculated that the overall maternal mortality was 13.4 per 100,000 for elective repeat cesarean delivery (ERCD) and 3.8 per 100,000 for TOLAC.[66] The rates of hysterectomy, hemorrhage, and transfusions did not differ significantly between TOLAC and ERCD.

Although maternal mortality is reduced by choosing TOLAC over ERCD, this choice is associated with increased fetal mortality. ERCD is associated with 0.5 perinatal deaths per 1000 births compared with 1.3 perinatal deaths per 1000 TOLAC births.[66] This TOLAC perinatal mortality rate is comparable to the perinatal mortality rate of laboring nulliparous women.[62] Hypoxic ischemic encephalopathy (HIE) is also slightly higher for TOLAC compared with ERCD, but "it is not possible to know the true relationship due to the low strength of overall evidence."[62,66,67]

TISSUE

Retained tissue (placenta, placental fragments, and blood clots) prevents the uterus from contracting enough to achieve optimal tone.

Retained Placenta

A small gush of blood with lengthening of the cord and a slight rise of the uterus in the pelvis are the classic signs of placental separation. Firm traction on the umbilical cord with one hand while the other applies suprapubic counter-pressure (Brandt maneuver) typically achieves placental delivery. The mean time from delivery until placental expulsion is eight to nine minutes.[5] A longer interval is associated with an increased risk of PPH, doubling after 10 minutes.[5] Retained placenta, defined as the failure of the placenta to deliver within 30 minutes after birth, occurs in less than three percent of vaginal deliveries.[68] Injecting the umbilical vein with saline and oxytocin (UVI) does not reduce the risk of retained placenta.[69]

If the placenta does not deliver after 30 minutes, manual removal of the placenta should be considered.[70] If the patient is stable, taking time to establish adequate analgesia is strongly recommended. This will make the procedure easier to perform and will reduce the patient's emotional and physical distress.

To manually remove the placenta:

1. Cease uterine massage and allow the uterus to relax. Subcutaneous or intravenous terbutaline 0.25 mg, intravenous nitroglycerin 100 to 200 mcg, or general anesthesia may infrequently be required to relax the uterus.[71] When medications for uterine relaxation are administered the patient can lose large amounts of blood, so it becomes imperative to accomplish the removal rapidly and then reverse the relaxation with oxytocic agents.
2. Identify the cleavage plane between the placenta and the uterine wall. Advance your fingertips in the plane until the entire placenta is free.
3. Cup the separated cotyledons into your palm. Deliver the placenta intact if possible.
4. After examining the uterine cavity and the placenta to ensure that the entire placenta and membranes have been removed, massage the uterus and give oxytocin.

If the cleavage plane cannot be identified or parts of the plane cannot be developed completely, prepare for surgical removal of the placenta:

1. Ensure that the patient has oxygen, two large bore intravenous catheters with replacement fluids running, adequate anesthesia started, proper surgical setup available, and appropriately trained providers present. Then, remove placental tissue either by vacuum or blunt curettage.
2. Curette the uterine cavity with a large blunt curette or large suction catheter. Take care to prevent perforating the soft, postpartum uterus.
3. Use ring forceps to grasp and remove placental tissue.

Invasive placenta can be life threatening.[68] The incidence has increased to at least 0.04 percent of deliveries, likely related to the increase in cesarean section rates.[35] Other risk factors include: prior invasive placenta, placenta previa (especially in combination with prior cesarean sections, increasing to 67 percent with placenta previa and four or more prior cesareans), advanced maternal age, and high parity.[35,68]

Classification is based on the depth of invasion. Placenta **a**ccreta **a**dheres to the myometrium, placenta **i**ncreta **i**nvades the myometrium, and placenta **p**ercreta **p**enetrates the myometrium to or beyond the serosa.[35,68] The usual treatment for invasive placenta is hysterectomy. For select patients, however, conservative management is sometimes successful. Conservative treatment options include partial removal of the placenta, arterial embolization, methotrexate and/or watchful waiting.[35,72] Women treated for a retained placenta must be observed for late sequelae, including infection and late postpartum bleeding.[35, 72]

THROMBIN

Coagulation disorders, a rare cause of PPH, are unlikely to respond to the uterine massage, uterotonics, and repair of lacerations.[1] Coagulation defects may be the cause and/or the result of a hemorrhage and should be suspected in those patients who have not responded to the usual measures to treat PPH, are not forming blood clots, or are oozing from puncture sites.

Many patients taking medications such as heparin or aspirin or who have chronic coagulopathies such as idiopathic thrombocytopenic purpura, thrombotic thrombocytopenic purpura, von Willebrand's disease, and hemophilia are identified prior to delivery, allowing advanced planning to prevent PPH. Coagulopathic bleeding before or during labor can be the result of HELLP syndrome (**H**emolysis

Elevated **L**iver enzymes and **L**ow **P**latelets) or disseminated intravascular coagulation (DIC). Obstetric conditions that can cause DIC include severe preeclampsia, amniotic fluid embolism, sepsis, placental abruption (often associated with cocaine use or hypertensive disorders), massive PPH and prolonged retention of fetal demise.[73]

Evaluation should include a platelet count, prothrombin time (INR), partial thromboplastin time, fibrinogen level, and fibrin split products (d-dimer). If rapid laboratory testing is not available, an empty whole blood tube ("red top") can be filled with maternal blood and taped to the wall. It should form a clot within five to 10 minutes. Management of coagulopathy consists of treating the underlying disease process, serially evaluating the coagulation status, replacing appropriate blood components, and supporting intravascular volume, using a massive transfusion protocol if indicated.[41,73]

POSTSTABILIZATION CARE AND DEBRIEFING

Postpartum hemorrhage can be frightening for the woman, her family, and her medical caregivers. Nine percent of women screen positive for posttraumatic stress disorder (PTSD) due to traumatic childbirth.[74] Treatment of a woman with postpartum hemorrhage does not conclude with control of bleeding and stabilization of her vital signs. Screening for, diagnosing, and treating acute stress disorder (occurring in the first month post-trauma) or PTSD is warranted to prevent long-term emotional sequelae. In addition to support of the health care team, patients with acute stress symptoms benefit from cognitive behavioral therapy.[75] Please see ALSO Birth Crisis chapter and workstation for more information regarding recommended post-trauma procedures and support for clinical staff.

Preventing Complications from PPH: A Systems-Based Approach

Complications of PPH are too common, even in high-resource countries and well-staffed delivery suites. Based on analysis of systems errors identified in The Joint Commission's 2010 Sentinel Event Alert, the Commission recommended that hospitals "identify specific triggers for responding to changes in the mother's vital signs and clinical condition and develop and use protocols and drills for responding to change, such as hemorrhage. Hospitals should use the drills to train staff in the protocols, to refine local protocols, and to identify and fix systems problems that would prevent optimal care."[76] The use of a massive transfusion protocol is one example of a systems approach to respond to obstetric emergencies.

ALSO training can be part of a systems approach to improve patient care. The use of interdisciplinary team training with in-situ simulation has been shown to improve perinatal safety.[77] Training hospital maternity care staff in an ALSO Provider course in a Tanzanian referral hospital significantly reduced the incidence of PPH and severe PPH.[78]

Global Perspectives: PPH

Although there is risk of PPH at every delivery, severe complications of PPH including maternal mortality are most common in developing countries.[6,7,33] Table 2 lists PPH risk factors, some of which may be more significant in developing countries, e.g., prolonged labor and chronic anemia from malnutrition or parasitic infections. Lack of skilled attendants, lack of access to medications to prevent and treat hemorrhage, and great distances from medical centers capable of providing blood transfusions and surgery further increase risks of PPH morbidity and mortality.[79] Uterine atony accounts for the majority of PPH in all settings. It is also important to consider causes that are more

common in low resource areas such as uterine rupture following prolonged/obstructed labors and genital tract lacerations in patients with female genital circumcision.

If used at every birth, active management of the third stage of labor would reduce PPH by 30 to 50 percent.[14,23] Oxytocin is the preferred drug for PPH prevention and treatment. However, it requires refrigeration and the use of vials and needles.[80] A single-dose, prefilled syringe, Uniject (Becton Dickinson, Franklin Lakes, NJ, USA) has been developed to decrease complexity of use.[81] If a health center cannot use or store oxytocin safely, misoprostol may be the preferred drug for prevention and treatment of PPH.[6] Misoprostol availability in some countries may be limited due to legal or political concerns related to the potential use of misoprostol for elective pregnancy termination. Other prevention strategies include: 1) detecting and correcting maternal anemia prior to delivery, and 2) avoiding unnecessary instrumental deliveries and routine episiotomy.[7,36,38] Treatment possibilities being evaluated for use in developing countries include the use of anti-shock garments and uterine tamponade with a hydrostatic condom catheter (sterile rubber catheter fitted with a condom, placed into the uterus through the vagina and inflated with 250 to 500 ml of saline).[47] Proprietary devices such as the Bakri™ balloon are effective for uterine atony but may not be readily available due to financial and logistical concerns.[45]

Additional details regarding PPH in developing countries can be found in the PPH Chapter Addendum of the Global ALSO Manual (available by calling (800) 274-2237 and at www.aafp.org/globalalso). In addition, the Global ALSO Maternal Resuscitation Chapter Addendum contains information on blood banking and blood transfusion.

SUMMARY

Postpartum hemorrhage is unpredictable and can occur in women with no risk factors. Active management of the third stage of labor (AMTSL) should be used routinely. AMTSL includes oxytocin after delivery of the fetal anterior shoulder and controlled cord traction with the Brandt maneuver. Uterine massage after delivery of the placenta is a reasonable approach and is included in some AMTSL protocols. Delayed cord clamping (one to three minutes after delivery) may be considered to decrease risk of infant anemia without increasing maternal hemorrhage risk.

Management of PPH requires rapid diagnosis and treatment. Diagnosis and treatment occur simultaneously using “The Four Ts” mnemonic. Uterine atony (TONE) is responsible for the majority of PPH, and can be effectively treated with uterine massage and uterotonic medications (oxytocin, misoprostol, methylergonovine, and 15-methyl prostaglandin F2 alpha). Oxytocin remains the first line medical treatment for treatment of PPH due to atony. TRAUMA, such as perineal lacerations and hematomas, is the second most common cause of PPH and may require intervention. The third most common cause of PPH, TISSUE, requires careful uterine exploration to remove clot and retained placenta and anticipation of the rare cases with invasive placenta. For women with suspected coagulopathy such as DIC, clotting factors need to be replaced and the cause of coagulopathy identified and corrected (THROMBIN). Early recognition, systematic evaluation and treatment, and prompt fluid resuscitation minimize the morbidity and mortality associated with postpartum hemorrhage, regardless of cause.

SUMMARY OF RECOMMENDATIONS

Strength of Recommendation – A

Active management of the third stage of labor should be utilized to decrease the risk of postpartum hemorrhage, postpartum maternal hemoglobin less than 9 mg/dL, and the need for manual removal of the placenta.[14,23]

Delayed cord clamping (one to three minutes) decreases neonatal risk of anemia and does not increase risk of PPH.[20-22]

Oxytocin remains the first choice for prevention of PPH because it is as, or more, effective than ergot alkaloids or prostaglandins and has fewer side effects.[16,22]

Misoprostol has advantages **for prevention** in low-resource settings because it is effective (NNT 18), inexpensive, heat stable, and simple to administer.[29,30]

Misoprostol is less effective **for prevention** of postpartum hemorrhage than oxytocin and has more side effects.[50,55,56]

Strength of Recommendation – B

The use of interdisciplinary team training with in-situ simulation has been shown to improve perinatal safety.[77]

REFERENCES

1. ACOG. ACOG Practice Bulletin: Clinical Management Guidelines for Obstetrician-Gynecologists Number 76, October 2006: Postpartum Hemorrhage, *Obstetrics and Gynecology* 2006;108:1039-47.
2. Stafford I Dildy GA, Clark SL, Belfort MA. Visually estimated and calculated Blood Loss in Vaginal and Cesarean Delivery. *American Journal of Obstetrics and Gynecology* 2008;199:519 E1-7.
3. Rajan PV, Wing DA. Postpartum Hemorrhage: Evidence-Based Medical Interventions For Prevention and Treatment. *Clinical Obstetrics And Gynecology* 2010;53:165-81.
4. Magann EF, Evans S, Hutchinson M, Collins R, Howard BC, Morrison JC. Postpartum Hemorrhage After Vaginal Birth: An Analysis of Risk Factors. *Southern Medical Journal* 2005;98:419-22.
5. Magann EF, Evans S, Chauhan SP, Lanneau G, Fisk AD, Morrison JC. The Length of The Third Stage of Labor and The Risk of Postpartum Hemorrhage. *Obstetrics and Gynecology* 2005;105:290-3.
6. Trends in Postpartum Hemorrhage in High Resource Countries: A Review and Recommendations from the International Postpartum Hemorrhage Collaborative Group. 2009. (Accessed At http://www.ncbi.nlm.nih.gov/pubmed/19943928.)
7. Al-Zirqi I, Vangen S, Forsen L, Stray-Pedersen B. Prevalence and Risk Factors of Severe Obstetric Haemorrhage. *BJOG* : An International Journal of Obstetrics and Gynaecology 2008;115:1265-72.
8. Trends in Maternal Mortality: 1990 to 2010. 2012. (Accessed Nov 22, 2013, At http://www.who.int/reproductivehealth/publications/monitoring/9789241503631/en/.)
9. Thompson Jf, Heal LJ, Roberts Cl, Ellwood DA. Women's Breastfeeding Experiences Following a Significant Primary Postpartum Haemorrhage: A Multicentre Cohort Study. *International Breastfeeding Journal* 2010;5:5.
10. Sentilhes L, Gromez A, Clavier E, Resch B, Descamps P, Marpeau L. Long-Term Psychological Impact of Severe Postpartum Hemorrhage. *Acta Obstetricia Et Gynecologica Scandinavica* 2011;90:615-20.
11. The 2009 National Blood Collection and Utilization Survey Report. Us Department of Health And Human Services, Office of the Assistant Secretary for Health, 2011. (Accessed November 22, 2013, At http://www.aabb.org/programs/biovigilance/nbcus/pages/default.aspx.)
12. Sert M, Tetiker T, Kirim S, Kocak M. Clinical Report Of 28 Patients with Sheehan's Syndrome. *Endocrine Journal* 2003;50:297-301.
13. Combs CA, Laros RL, Jr. Prolonged Third Stage of Labor: Morbidity And Risk Factors. *Obstetrics and Gynecology* 1991;77:863-7.
14. Begley CM, Gyte GM, Devane D, Mcguire W, Weeks A. Active Versus Expectant Management for Women in the Third Stage of Labour. Cochrane Database Syst Rev 2011:CD007412.
15. Hofmeyr GJ, Abdel-Aleem H, Abdel-Aleem MA. Uterine Massage for Preventing Postpartum Haemorrhage. Cochrane Database Syst Rev 2008:Cd006431.
16. Tuncalp O, Hofmeyr GJ, Gulmezoglu AM. Prostaglandins for Preventing Postpartum Haemorrhage. Cochrane Database Syst Rev 2012;8:CD000494.
17. Chen M, Chang Q, Duan T, He J, Zhang L, Liu X. Uterine Massage to Reduce Blood Loss After Vaginal Delivery: A Randomized Controlled Trial. *Obstetrics And Gynecology* 2013;122:290-5.
18. Abdel-Aleem H, Hofmeyr GJ, Shokry M, El-Sonoosy E. Uterine Massage And Postpartum Blood Loss. International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics 2006;93:238-9.
19. Lalonde A, Daviss BA, Acosta A, Herschderfer K. Postpartum Hemorrhage Today: ICM/Figo Initiative 2004-2006. International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics 2006;94:243-53.
20. Mcdonald SJ, Middleton P. Effect of Timing of Umbilical Cord Clamping of Term Infants on Maternal and Neonatal Outcomes. Cochrane Database Syst Rev 2008:CD004074.
21. Andersson O, Hellstrom-Westas L, Andersson D, Domellof M. Effect of Delayed Versus Early Umbilical Cord Clamping on Neonatal Outcomes and Iron Status at 4 Months: A Randomised Controlled Trial. *BMJ* 2011;343:D7157.
22. Mercer JS, Vohr BR, Mcgrath MM, Padbury JF, Wallach M, Oh W. Delayed Cord Clamping in Very Preterm Infants Reduces the Incidence of Intraventricular Hemorrhage and Late-Onset Sepsis: A Randomized, Controlled Trial. *Pediatrics* 2006;117:1235-42.
23. Cotter Am NA, Tolosa JE. Prophylactic Oxytocin for The Third Stage of Labour. Cochrane Database of Systematic Reviews 2001 (Updated In 2004).
24. Prendiville WJ, Harding JE, Elbourne DR, Stirrat GM. The Bristol Third Stage Trial: Active Versus Physiological Management of Third Stage of Labour. *BMJ* 1988;297:1295-300.
25. Stanton C, Armbruster D, Knight R, Et Al. Use of Active Management of The Third Stage of Labour in Seven Developing Countries. Bulletin of The World Health Organization 2009;87:207-15.
26. Rizvi F, Mackey R, Barrett T, Mckenna P, Geary M. Successful Reduction of Massive Postpartum Haemorrhage by Use of Guidelines And Staff Education. *BJOG* : An International Journal of Obstetrics and Gynaecology 2004;111:495-8.
27. Davies GA, Tessier Jl, Woodman MC, Lipson A, Hahn PM. Maternal Hemodynamics After Oxytocin Bolus Compared with Infusion in The Third Stage of Labor: A Randomized Controlled Trial. *Obstetrics and Gynecology* 2005;105:294-9.

28. Leduc D, Senikas V, Lalonde Ab, Et Al. Active Management of The Third Stage of Labour: Prevention and Treatment of Postpartum Hemorrhage. *J Obstet Gynaecol Can* 2009;31:980-93.

29. Bellad M, Tara D, Ganachari M, Et Al. Prevention of Postpartum Haemorrhage with Sublingual Misoprostol or Oxytocin: A Double-Blind Randomised Controlled Trial. *BJOG* : An International Journal of Obstetrics and Gynaecology 2012;119:975-86.

30. Derman RJ, Kodkany BS, Goudar SS, Et Al. Oral Misoprostol in Preventing Postpartum Haemorrhage in Resource-Poor Communities: A Randomised Controlled Trial. *Lancet* 2006;368:1248-53.

31. Sheldon WR, Blum J, Durocher J, Winikoff B. Misoprostol for the Prevention and Treatment of Postpartum Hemorrhage. Expert Opinion on Investigational Drugs 2012;21:235-50.

32. Elati A, Weeks A. Risk of Fever after Misoprostol for the Prevention of Postpartum Hemorrhage: A Meta-Analysis. *Obstetrics and Gynecology* 2012;120:1140-8.

33. Who. Guidelines for the Management of Postpartum Haemorrhage and Retained Placenta. In: Organization WH, ED. Geneva; 2009.

34. Eller AG, Bennett MA, Sharshiner M, Et Al. Maternal Morbidity in Cases of Placenta Accreta Managed by a Multidisciplinary Care Team Compared with Standard Obstetric Care. *Obstetrics and Gynecology* 2011;117:331-7.

35. ACOG. Committee Opinion No. 529: Placenta Accreta. *Obstetrics and Gynecology* 2012;120:207-11.

36. ACOG. ACOG Practice Bulletin No. 78: Hemoglobinopathies in Pregnancy. *Obstetrics and Gynecology* 2007;109:229-37.

37. Aasheim V, Nilsen AB, Lukasse M, Reinar LM. Perineal Techniques during the Second Stage of Labour for Reducing Perineal Trauma. Cochrane Database Syst Rev 2011:CD006672.

38. Carroli G, Mignini L. Episiotomy for Vaginal Birth. Cochrane Database Syst Rev 2009:CD000081.

39. O'Mahony F, Hofmeyr GJ, Menon V. Choice of Instruments for Assisted Vaginal Delivery. Cochrane Database Syst Rev 2010:CD005455.

40. OB Hemorrhage Care Guideline. 2010. (Accessed November 20, 2013, 2013, At https://http://www.cmqcc.org/resources/ob_hemorrhage/ob_hemorrhage_care_guidelines_checklist_flowchart_tablechart_v1_4.)

41. Burtelow M, Riley E, Druzin M, Fontaine M, Viele M, Goodnough Lt. How We Treat: Management of Life-Threatening Primary Postpartum Hemorrhage with a Standardized Massive Transfusion Protocol. Transfusion 2007;47:1564-72.

42. Prevention and Management of Postpartum Haemorrhage. Guidelines and Audit Committee of the Royal College of Obstetricians and Gynaecologists, 2009. (Accessed Nov 22, 2013, At http://www.rcog.org.uk/eomens-health/vlinical-guidance/prevention-and-management-postpartum-haemorrhage-green-top-52.)

43. Bonnet MP, Deneux-Tharaux C, Bouvier-Colle MH. Critical Care and Transfusion Management in Maternal Deaths from Postpartum Haemorrhage. European Journal of Obstetrics, Gynecology, and Reproductive Biology 2011;158:183-8.

44. Riley DP, Burgess RW. External Abdominal Aortic Compression: A Study of a Resuscitation Manoeuvre for Postpartum Haemorrhage. Anaesthesia and Intensive Care 1994;22:571-5.

45. Georgiou C. Balloon Tamponade in the Management of Postpartum Haemorrhage: A Review. *BJOG* : An International Journal of Obstetrics and Gynaecology 2009;116:748-57.

46. Schmid BC, Rezniczek GA, Rolf N, Saade G, Gebauer G, Maul H. Uterine Packing with Chitosan-Covered Gauze for Control of Postpartum Hemorrhage. *American Journal of Obstetrics and Gynecology* 2013;209:225 E1-5.

47. Miller S, Martin HB, Morris Jl. Anti-Shock Garment in Postpartum Haemorrhage. *Best Practice & Research Clinical Obstetrics & Gynaecology* 2008;22:1057-74.

48. ACOG. Patient Safety Checklist Number 10: Postpartum Hemorrhage from Vaginal Delivery. *Obstetrics and Gynecology* 2013;120:1256-7.

49. Gronvall M, Tikkanen M, Tallberg E, Paavonen J, Stefanovic V. Use of Bakri Balloon Tamponade in The Treatment of Postpartum Hemorrhage: A Series of 50 Cases from a Tertiary Teaching Hospital. *Acta Obstetricia Et Gynecologica Scandinavica* 2013;92:433-8.

50. Mousa HA, Alfirevic Z. Treatment for Primary Postpartum Haemorrhage. Cochrane Database Syst Rev 2007:Cd003249.

51. Lexi-Comp™. Methylergonovine: Drug Information. Waltham, MA: Uptodate; 2012.

52. Oleen MA, Mariano JP. Controlling Refractory Atonic Postpartum Hemorrhage with Hemabate Sterile Solution. *American Journal of Obstetrics and Gynecology* 1990;162:205-8.

53. Winikoff B, Dabash R, Durocher J, Et Al. Treatment of Post-Partum Haemorrhage with Sublingual Misoprostol Versus Oxytocin in Women Not Exposed to Oxytocin During Labour: A Double-Blind, Randomised, Non-Inferiority Trial. *Lancet* 2010;375:210-6.

54. Treatment of Post-Partum Haemorrhage with Misoprostol. Figo, 2012. (Accessed Nov 22, 2013, At http://www.k4health.org/sites/default/files/treatment of Post-Partum Haemorrhage With Misoprostol Figo Guideline.Pdf.)

55. Blum J, Winikoff B, Raghavan S, Et Al. Treatment of Post-Partum Haemorrhage with Sublingual Misoprostol Versus Oxytocin in Women Receiving Prophylactic Oxytocin: A Double-Blind, Randomised, Non-Inferiority Trial. *Lancet* 2010;375:217-23.

56. Widmer M, Blum J, Hofmeyr GJ, Et Al. Misoprostol as an Adjunct to Standard Uterotonics for Treatment of Post-Partum Haemorrhage: A Multicentre, Double-Blind Randomised Trial. *Lancet* 2010;375:1808-13.

57. Dildy GA, 3rd. Postpartum Hemorrhage: New Management Options. *Clinical Obstetrics and Gynecology* 2002;45:330-44.

58. Benrubi G, Neuman C, Nuss RC, Thompson RJ. Vulvar and Vaginal Hematomas: A Retrospective Study of Conservative Versus Operative Management. *Southern Medical Journal* 1987;80:991-4.

59. You WB, Zahn CM. Postpartum Hemorrhage: Abnormally Adherent Placenta, Uterine Inversion, and Puerperal Hematomas. *Clinical Obstetrics and Gynecology* 2006;49:184-97.

60. Gulmezoglu AM, Widmer M, Merialdi M, Et Al. Active Management of the Third Stage of Labour Without Controlled Cord Traction: A Randomized Non-Inferiority Controlled Trial. *Reproductive Health* 2009;6:2.

61. Shah-Hosseini R, Evrard Jr. Puerperal Uterine Inversion. *Obstetrics and Gynecology* 1989;73:567-70.

62. Cunningham GF. National Institutes of Health Consensus Development Conference Statement: Vaginal Birth after Cesarean: New Insights March 8-10, 2010. *Obstetrics And Gynecology* 2010;115:1279-95.

63. Spong CY, Mercer BM, D'Alton M, Kilpatrick S, Blackwell S, Saade G. Timing of Indicated Late-Preterm and Early-Term Birth. *Obstetrics and Gynecology* 2011;118:323-33.

64. ACOG. ACOG Practice Bulletin No. 115: Vaginal Birth after Previous Cesarean Delivery. *Obstetrics and Gynecology* 2010;116:450-63.

65. Landon MB, Hauth JC, Leveno KJ, Et Al. Maternal and Perinatal Outcomes Associated with a Trial of Labor after Prior Cesarean Delivery. *The New England Journal Of Medicine* 2004;351:2581-9.

66. Guise JM, Eden K, Emeis C, Et Al. Vaginal Birth after Cesarean: New Insights. Evidence Report/Technology Assessment 2010:1-397.

67. Guise JM, McDonagh MS, Osterweil P, Nygren P, Chan BK, Helfand M. Systematic Review of the Incidence and Consequences of Uterine Rupture in Women with Previous Caesarean Section. *BMJ* 2004;329:19-25.

68. Wu S, Kocherginsky M, Hibbard JU. Abnormal Placentation: Twenty-Year Analysis. *American Journal Of Obstetrics and Gynecology* 2005;192:1458-61.

69. Nardin JM, Weeks A, Carroli G. Umbilical Vein Injection for Management of Retained Placenta. *Cochrane Database Syst Rev* 2011:Cd001337.

70. Weeks Ad. The Retained Placenta. Best Practice & Research Clinical Obstetrics & Gynaecology 2008;22:1103-17.

71. Axemo P, Fu X, Lindberg B, Ulmsten U, Wessen A. Intravenous Nitroglycerin for Rapid Uterine Relaxation. *Acta Obstetricia Et Gynecologica Scandinavica* 1998;77:50-3.

72. Timmermans S, Van Hof AC, Duvekot JJ. Conservative Management of Abnormally Invasive Placentation. *Obstetrical & Gynecological Survey* 2007;62:529-39.

73. Richey ME, Gilstrap LC, 3rd, Ramin Sm. Management of Disseminated Intravascular Coagulopathy. *Clinical Obstetrics And Gynecology* 1995;38:514-20.

74. Beck CT, Gable RK, Sakala C, Declercq Er. Posttraumatic Stress Disorder in New Mothers: Results from a Two-Stage U.S. National Survey. *Birth* 2011;38:216-27.

75. Roberts NP, Kitchiner NJ, Kenardy J, Bisson JI. Early Psychological Interventions to Treat Acute Traumatic Stress Symptoms. Cochrane Database Syst Rev 2010:Cd007944.

76. Jointcommision. Preventing Maternal Death. *Jt Comm Perspect Jrnl* 2010;30:7-9.

77. Riley W, Davis S, Miller K, Hansen H, Sainfort F, Sweet R. Didactic and Simulation Nontechnical Skills Team Training to Improve Perinatal Patient Outcomes in a Community Hospital. Joint Commission *Journal on Quality And Patient Safety*/Joint Commission Resources 2011;37:357-64.

78. Sorensen Bl, Rasch V, Massawe S, Nyakina J, Elsass P, Nielsen BB. Advanced Life Support in Obstetrics (ALSO) and Post-Partum Hemorrhage: A Prospective Intervention Study in Tanzania. *Acta Obstetricia Et Gynecologica Scandinavica* 2011;90:609-14.

79. Ronsmans C, Graham WJ. Maternal Mortality: Who, When, Where, And Why. *Lancet* 2006;368:1189-200.

80. Gard JW, Alexander JM, Bawdon Re, Albrecht JT. Oxytocin Preparation Stability in Several Common Obstetric Intravenous Solutions. *American Journal Of Obstetrics And Gynecology* 2002;186:496-8.

81. Althabe F, Mazzoni A, Cafferata Ml, Et Al. Using Uniject to Increase the Use of Prophylactic Oxytocin for Management of the Third Stage of Labor in Latin America. International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics 2011;114:184-9.