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Managing the Ten Most Common Life-Threatening Scenarios Associated with Postpartum Hemorrhage

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INTRODUCTION

Treatment of postpartum hemorrhage (PPH) is never simple, and many paradigms have been presented for consideration over the past several years. Most advocate straightforward approaches directed toward a specific cause of PPH. Rarely have authors put forward a series of treatment plans in the same document that describe treatment related to a variety of causes. The impetus to prepare this chapter derives from a thorough review of published data relating to specific deaths from PPH as described in the Confidential Enquires of the UK[1], Australia[2] and Canada[3]. American data[4], in contrast, are mostly descriptive and contain statistical elements relating to maternal deaths without individual case analyses.

The recurring theme of these reports is quite simple: TOO LITTLE, TOO LATE. Because PPH is episodic in nature and almost always unexpected, birth attendants are not prepared to deal with it on a regular and recurring basis. This is especially true if the PPH appears at night, on weekends, or on holidays, or if the care provider is alone in the delivery unit at the time of its occurrence and is unwilling or unable to seek competent help in a timely manner or if such help is unavailable. Figure 1 (also shown in Chapter 20 by Gangopadhyay *et al.*) shows a 25-year analysis of deaths in the UK reports in which 60–70% of patients received what was described as substandard care.

After analysis of existing reports, we selected ten common PPH scenarios which might be seen by an average obstetrician in his or her practice. All invariably commence as simple challenges which, when appropriate actions are not taken in a timely manner, may lead to serious morbidity and eventually death.

The late Steve Jobs, founder of Apple Computers, was fond of saying that it was extremely difficult to make complex things simple, whereas it was easy to make simple things complex. This statement applies directly to the therapy of PPH because, as the ten scenarios show, the causes of the PPH vary from simple to complex at their onset, and even simple cases become complex with a very short passage of time. This latter thought was described in various terms by authors in the first edition of this text, but no author made the point illustrated in the following box.

> The passage of time is likely to increase the complexity of any given case because continuous bleeding, not appropriately and adequately controlled on a timely basis, invariably leads to coagulopathy.

Once coagulopathy sets in, the simplest case takes a different path, as the need to treat coagulopathy complicates any other planned interventions. Thus, one hears of cases in which compression sutures, embolizations, the use of factor VIIa or even hysterectomies failed to control PPH. When these cases are analysed retrospectively, however, it becomes clear that the practitioners failed to realize they were attempting to correct bleeding from coagulopathy which had not been recognized or even considered.

Seven of the ten scenarios are preceded by an algorithm, and study of these algorithms in conjunction with the proposed therapy reinforces the need to progress from one step to the next in a logical manner. These algorithms have been prepared in such a manner that the reader understands therapy not only progresses logically, but also does so with one eye on the clock. Stated another way, if medical therapy using three or four uterotonic agents has not worked within 1 hour, there is no logical reason to think that it will work in the next hour. Similarly, if compression sutures are delayed until the onset of coagulopathy,
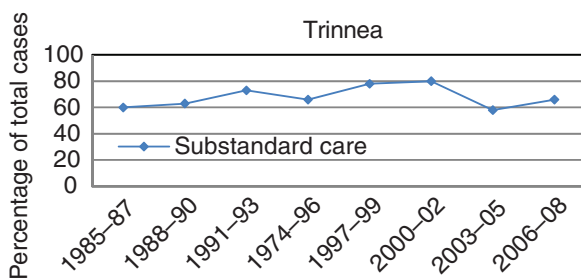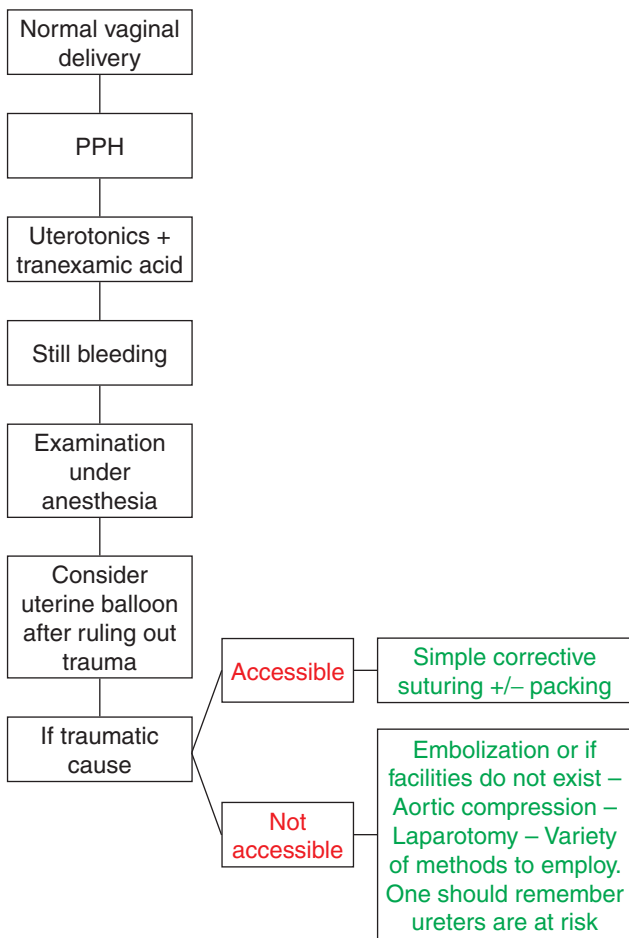

Figure 1 Trends in substandard care (see Chapter 20)

there is no reason to think that they will work unless the coagulopathy has been treated.

It is our earnest hope that this chapter will provide the practitioner with the realization that one specific therapy cannot possibly work for all causes of PPH and that different therapeutic pathways must be chosen depending upon the inherent cause of bleeding. To this end, this chapter makes full use of web links, video clips, illustrations and hyperlinks to other supporting materials, these can be accessed through *The Global Library of Women's Medicine* at www.glowm.com.

SCENARIO 1 – VAGINAL DELIVERY AND PPH

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┌─────────────────┐
│ Normal vaginal  │
│    delivery     │
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         │
┌────────┴────────┐
│       PPH       │
└────────┬────────┘
         │
┌────────┴────────┐
│  Uterotonics +  │
│ tranexamic acid │
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         │
┌────────┴────────┐
│  Still bleeding │
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         │
┌────────┴────────┐
│   Examination   │
│      under      │
│   anesthesia    │
└────────┬────────┘
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┌────────┴────────┐
│    Consider     │           ┌──────────────┐        ┌─────────────────────┐
│ uterine balloon │           │  Accessible  ├────────┤ Simple corrective   │
│ after ruling out├───────────┤              │        │ suturing +/– packing│
│     trauma      │           └──────────────┘        └─────────────────────┘
└────────┬────────┘
         │                                             ┌─────────────────────┐
┌────────┴────────┐          ┌──────────────┐          │ Embolization or if  │
│  If traumatic   ├──────────┤     Not      ├──────────│ facilities do not   │
│     cause       │          │  accessible  │          │ exist –             │
└─────────────────┘          └──────────────┘          │ Aortic compression –│
                                                        │ Laparotomy – Variety│
                                                        │ of methods to employ│
                                                        │ One should remember │
                                                        │ ureters are at risk │
                                                        └─────────────────────┘
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Scenario 1 – Vaginal delivery and PPH

The key to appropriate initiation of therapy in this scenario is to immediately recognize when the patient has lost more than 500 ml of blood or when the hemorrhage has begun to compromise vital signs, as might occur in a woman who entered labor with a hemoglobin of less than 7 g/dl and subsequently loses a mere 200 ml of blood.

At the same time, it is important to recognize that if the woman in the algorithm has had a labor lasting 24 hours or more, her blood loss may be from at least two additional causes besides atony, as both genital tract trauma and associated postlabor dehydration may accentuate the severity and rapid deterioration of clinical parameters.

Because uterine atony is the most logical cause of bleeding in such cases, the use of uterotonic agents represents an appropriate initial therapeutic pathway. Discussions as to which specific uterotonic agent to administer and how to do it are found in other chapters of this book (Section 8). In general oxytocin, Syntocinon®, methergin, prostaglandins and carbetocin are used with similar degrees of success in settings that can provide proper storage of these agents. In contrast oral, vaginal and rectal doses of misoprostol are particularly valuable in areas of the world where standard oxytocics are not available (see Section 6).

The use of tranexamic acid is well characterized in the trauma literature, but not well described in the obstetric literature, although anecdotal reports of its widespread use and success in the treatment of PPH abound. In addition, it is commonly used by cardiothoracic and hepatobiliary surgeons to control bleeding. It does so by stabilizing the clot.

If bleeding continues or even accelerates during the process of medical therapy, it is prudent to conduct a thorough examination of the vaginal walls and vault as well as to examine the cervix for tears whilst using some form of anesthetic. In order to perform such an examination, it is necessary to have at least one assistant, suitable equipment and a light source that illuminates the vaginal vault. Whilst this is taking place, a team member should examine or re-examine the placenta for the missing cotyledons.

Assuming that no obvious vaginal or cervical trauma is recognized and the bleeding continues, any one of the available uterine balloons should be used (for details see Chapters 46–48 and 54).

If vaginal trauma is found to be the principal cause of the bleeding, practitioners may be confronted with one of three different circumstances. In the first, there may be one or two tears of the vagina which are amenable to simple corrective suturing. If, on the other hand, tears are of an explosive nature, i.e. multiple small tears not amenable to individual suturing, or if sutures pull through the edematous tissue thereby causing more bleeding, it is reasonable to inflate a balloon which compresses the entire vaginal wall throughout its circumference. If no balloons are available, packing the vagina with antiseptic impregnated gauge can also be of value. The third variation is the most serious. It is the deep vaginal tear that extends into the abdominal cavity causing either a retroperitoneal hematoma(s) or compromising the urinary tract. An illustration of this variation is found in the Chapter 23 by B-Lynch. It is important to remember that a simple suture of the vaginal wall over what looks to be a deep tear in the posterior or lateral wall may include the rectum, bladder and/or ureter, even though ureteric injury with a tear is most unlikely.

Adequate exposure may be needed and can be achieved by performing an episiotomy (if not present already or if it is too small can be extended) and using a Dever's retractor for the posterior vaginal wall and a Langden or vaginal retractor for the anterolateral vaginal wall. Long Aliss tissue forceps are useful to apply to

the vaginal wall near the apex of the tear. It is adequate and better to suture each side of the vaginal wall separately without trying to approximate adjacent walls of the tear to avoid obliterating the view higher up and also causing tension tears of the vagina. The gap left behind will epithelialize rapidly in a few weeks. A suture position as high as possible should be used as a stay suture and traction applied to the suture higher up to arrest bleeding. The consecutive sutures can be held together as stay sutures to prevent tearing of the vaginal wall. Usually bleeding is from an artery that had retracted under the vaginal wall and hence the suture needs to be higher than and lateral to the apex of the tear. Treatment of this variation may involve a combined vaginal–abdominal approach on either side of the trauma (see Chapter 24).

If concerns exist about ureteric injury, immediate cystoscopy can confirm the presence of urinary efflux on both sides of the bladder demonstrating the integrity of the ureters. If cystoscopy cannot be accomplished immediately, an intravenous pyelogram (IVP) can be performed the next day.

In some circumstances, especially those cases being conducted in tertiary centers with full facilities, it may be prudent to correct the coagulopathy and institute embolization before embarking on laparotomy (see Chapters 49 and 50). In other circumstances it is necessary to consider transfer of the bleeding patient to a specialist center with capability for arterial embolization. Two cautionary points are important. First, it is inappropriate to transfer a patient in shock, because the condition will only deteriorate during the transfer process and waiting for the procedure. Second, patients in shock and with coagulopathy are not suitable candidates for embolization. Under such circumstances, the vascular system is in a state of constriction which impedes blood flow in the bleeding vessels. The actual average procedure time for a fully trained interventional radiologist is 1 hour. This does not include transfer and preparation time. One should not forget that fluids and hemostatic support must be provided during the transfer and procedure. Further discussion is found in Chapter 49, in addition, Chapters 38 and 39 describes the use of non-pneumatic antishock garment (NASG) which redistributes blood from the lower extremities to the central circulatory system of the major organs (heart, kidneys, brain).

SCENARIO 2 – INSTRUMENTAL DELIVERY AND PPH

Scenario 2A – ventouse delivery and PPH

When bleeding begins after a ventouse delivery, it is important to distinguish whether it is from a vaginal laceration(s) *per se* or a combination of uterine atony plus vaginal laceration(s). If uterine atony is present, blood will be coming from the cervix in addition to any bleeding that flows from the vaginal walls secondary to trauma. Treatment of the atonic bleeding should follow directions given in Scenario number 1
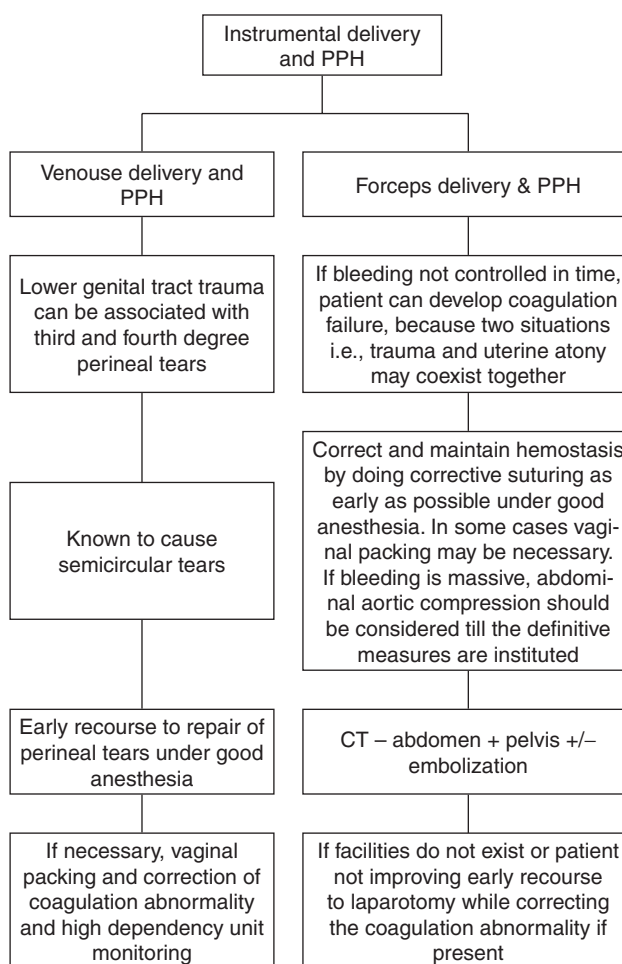
Scenario 2 – Instrumental delivery and PPH

as well as information provided in chapters in Section 8.

Ventouse related lacerations often are circular in nature because of the physical nature of the instrument used. The lacerations are caused by the inadvertent incorporation of vaginal tissue into the ventouse when it slips. Unlike traumatic lacerations which normally take a linear form, these lacerations may actually represent an area of missing vaginal tissue which has been denuded. Because of the friable nature of the vaginal walls, packing is generally advocated using long cotton gauze previously moistened with saline or antiseptic solution. This can remain in place for 24 hours when it can be gently removed. More recently, a specially devised vaginal balloon has been used successfully in these cases (see Chapter 54). Both methodologies provide pressure against the bleeding surfaces.

Rectal and bladder injuries are rare but may occur with instrumental vaginal deliveries (Figure 2). Hence it is important to determine that neither the bladder nor the rectum has been injured after each ventouse delivery. Non-recognition of a bladder or rectal laceration will result in fistula formation and is often followed by litigation issues. Effective anesthesia is paramount for repair efforts. In such cases transfusion may or may not be indicated depending upon the extent of the blood loss and deterioration of vital signs.

Scenario 2B – forceps delivery and PPH

Bleeding after a vaginal delivery with forceps can be complicated by factors that occur prior to delivery. If the woman has had a prolonged labor with or without a prolonged second stage, the likelihood of the coexistence of different causes of PPH is high. For example, such a woman is likely to be dehydrated, uterine atony is more likely to be present, and genital tract trauma may be so severe that its repair by an inexperienced operator would be prolonged, and ineffective in controlling blood loss.

The bleeding from uterine atony appropriately has been described as S1 segment bleeding (Figure 3), a term which is related to the fact that it comes from the upper part of the uterus which is supplied mainly by the ascending branch of the uterine artery (90%) and secondarily by the ovarian artery (10%)[5]. At the same time, bleeding from cervical lacerations or the superior aspect of the vaginal vault is characterized as S2 segment bleeding. Such bleeding mainly derives from two vessels: first, the descending branch of the uterine artery; and second, the vaginal artery which usually arises from the posterior division of internal iliac artery (see Chapter 1).

In such instances, if the patient is taken for an embolization procedure, it is important that the radiologist realize that the vaginal artery is not a branch of the anterior division of the internal iliac artery and that the embolization catheter must enter the posterior internal iliac branch. If the radiologist embolizes the posterior division of the internal iliac to control lower vaginal bleeding, the patient is at risk of having a non-target embolization of the inferior gluteal vessel which supplies the sciatic nerve.

In order to avoid this problem, the bilateral insertion of a balloon into the common iliac arteries is required to provide time (90 min) (Jose Palacios Jaraquemada – personal communication, 31 October 2011) for the surgeon to reach the bleeding field with appropriate instruments or the interventional radiologist to attempt embolization a second time (Figure 4).

The nature and extent of vaginal lacerations cannot be properly assessed in the absence of good light and proper assistance with long retractors. Vaginal lacerations may be simple linear tears or explosive in nature. In addition, they may extend deeply into one or both fornices.

If good assistance is not obtained rapidly and the multiple causes of bleeding are not addressed promptly and adequately, the patient's chance of developing acute coagulation failure and its resultant comorbidities is extremely high.

Depending upon the extent and quantity of the blood loss, external (and sometimes internal) aortic compression (Videos 1 and 2) may be of great use to gain extra time when the patient is being assessed for the extent of her injuries and early resuscitative measures are being applied. It goes without saying that volume replacement and correction of anemia, acidosis and prevention of hypothermia
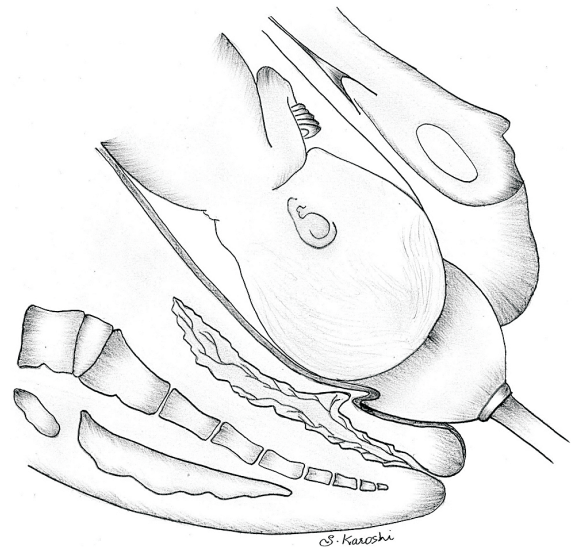

Figure 2 Schematic diagram showing incorrect application of ventouse cup in occiput-posterior position which potentially may cause fourth degree tear causing rectovaginal fistula
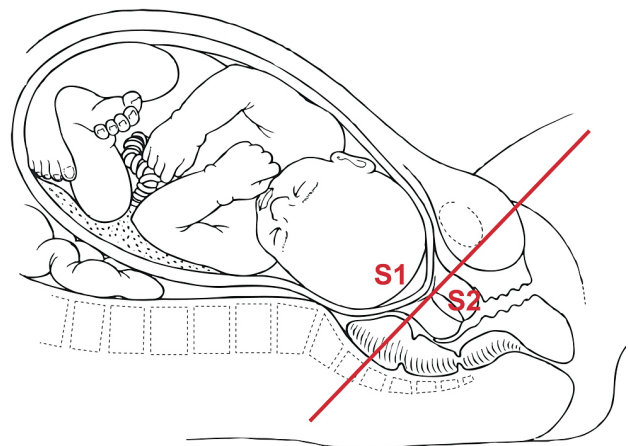

Figure 3 Segment S1 and S2 bleeding: S1, the upper part of the uterus which is supplied mainly by the ascending branch of the uterine artery (90%) and secondarily by the ovarian artery (10%) and S2 the lower part of the uterus supplied by the descending branch of the uterine artery and the vaginal artery. Courtesy of Palacios-Jaraquemada
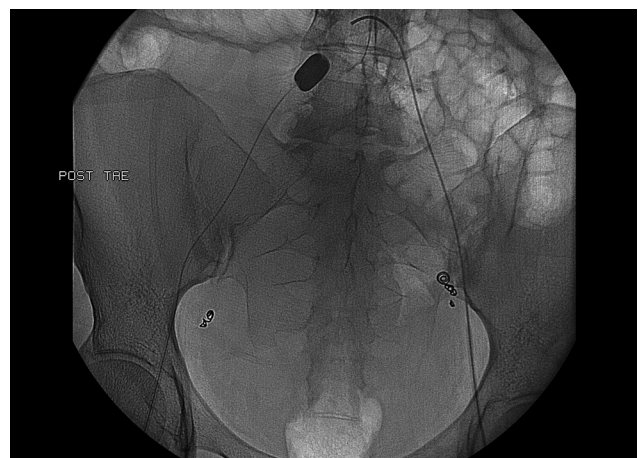

Figure 4 Interventional radiology X-ray image of common iliac balloon. Courtesy of Dr Shih, Jin-Chung, Department of Obstetrics and Gynecology, National Taiwan University Hospital and National Taiwan University College of Medicine, Taipei, Taiwan

must take place while these other interventions are being carried out. In addition, it must be remembered that the continuation of bleeding will precede the onset of coagulopathy. A full discussion of the recent changes in the ratios of fibrinogen to red cells in various transfusion protocols is provided in Chapters 3, 4 and 6.

The present scenario illustrates the concept that PPH cannot be considered solely a uterine problem. Rather, PPH is a condition which affects the entire system and has the potential to have adverse consequences on multiple organs if not treated properly and in a timely manner.

The tendency to perform hysterectomy often is seen in situations such as the one described above. What the practitioner may not realize is that hysterectomy is designed to treat bleeding from the uterine fundus (S1 area) and will not effectively treat bleeding from the lower uterine segment/cervix, parametrium and upper vagina (S2 area), because the bleeding pedicles are different. In fact, performing hysterectomy in such instances may worsen the overall condition of the patient. Moreover, performing hysterectomy will deplete at least 1.5 liters of blood from the already compromised patient's circulation.

SCENARIO 3 – PPH IN THE RECOVERY AREA FOLLOWING ELECTIVE CESAREAN DELIERY

A cesarean section is always major surgery. Therefore, it can cause complications like any other major surgery. PPH following elective cesarean is not an uncommon event. Close vigilance, appropriate monitoring (modified early warning score (MEWS) chart) and seeking help at the appropriate time will avert further serious complications and death.

Patient deterioration can be secondary to revealed PPH or concealed PPH. Concealed PPH is more dangerous than the revealed. Common reasons for the patient to suffer PPH following elective cesarean are atonic uterus, retained fragments of placenta, bleeding uterine angle and rectus sheath hematoma. Detailed examination including checking for vitals signs and
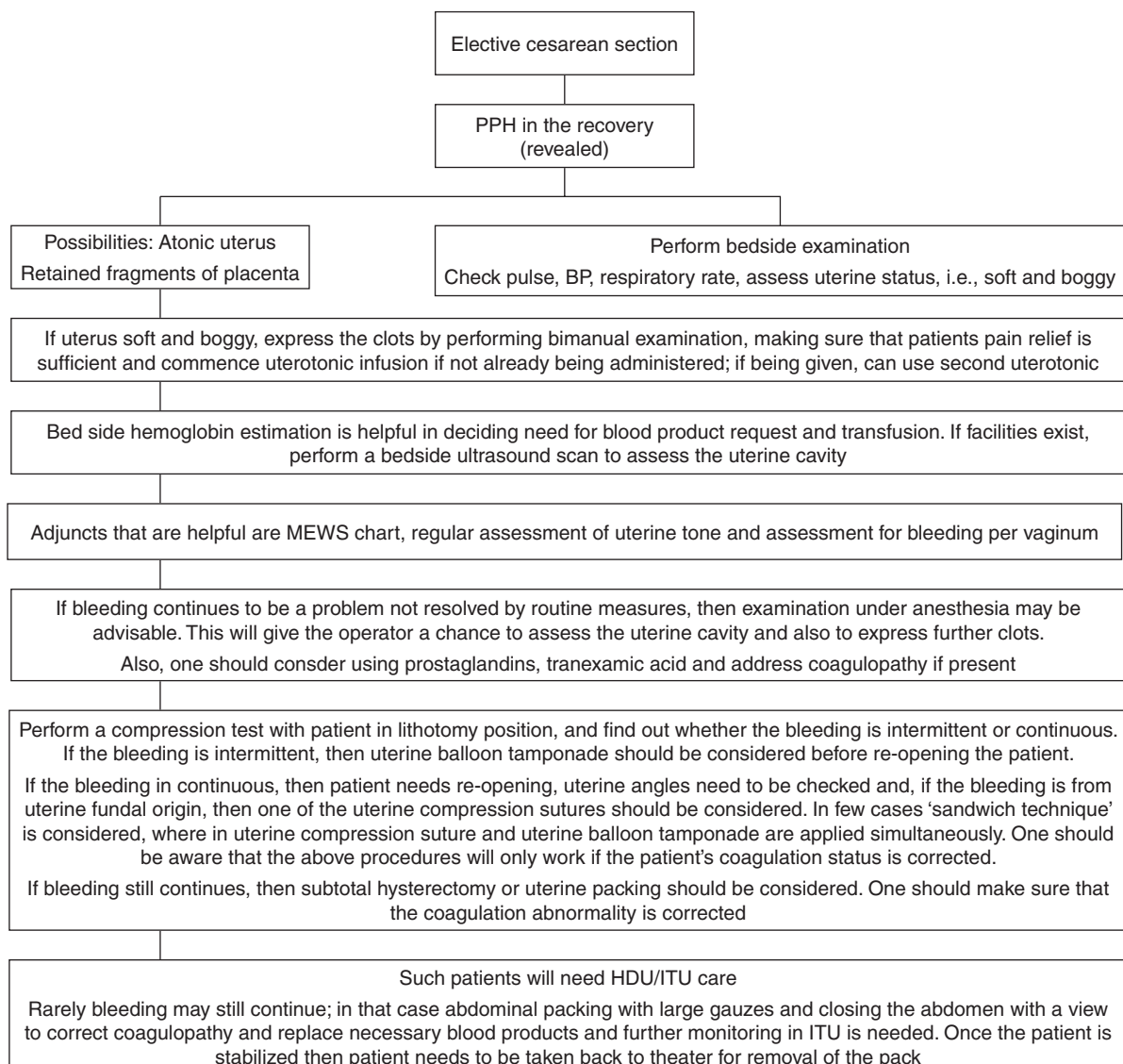
Scenario 3 – PPH in the recovery area following elective cesarean delivery

abdominal and bimanual examination by an experienced professional will usually yield clues as to the origin of the bleeding. If the bleeding is of uterine origin, the uterus is usually soft and markedly enlarged.

If uterine atony is the cause of the PPH, the uterus will be filled with clots, and the patient requires examination under anesthesia, preferably in an operating theater. Clots must be expressed from the uterine cavity and uterine tone sustained or increased by use of an additional uterotonic, assuming that one is already in use.

If bleeding still continues to be a problem and is not relieved by the above measures, then examination under anesthesia should be considered in order to allow assessment of the uterine cavity, expression of further clots and, if necessary, insertion of a uterine balloon tamponade (see Scenario 1).

A uterine compression test should be performed. If bleeding is intermittent, the balloon tamponade should work (see Chapters 45, 47 and 48). If bleeding is continuous, however, the patient will require re-opening. Uterine compression sutures/sandwich technique will only work if there is no coagulopathy.
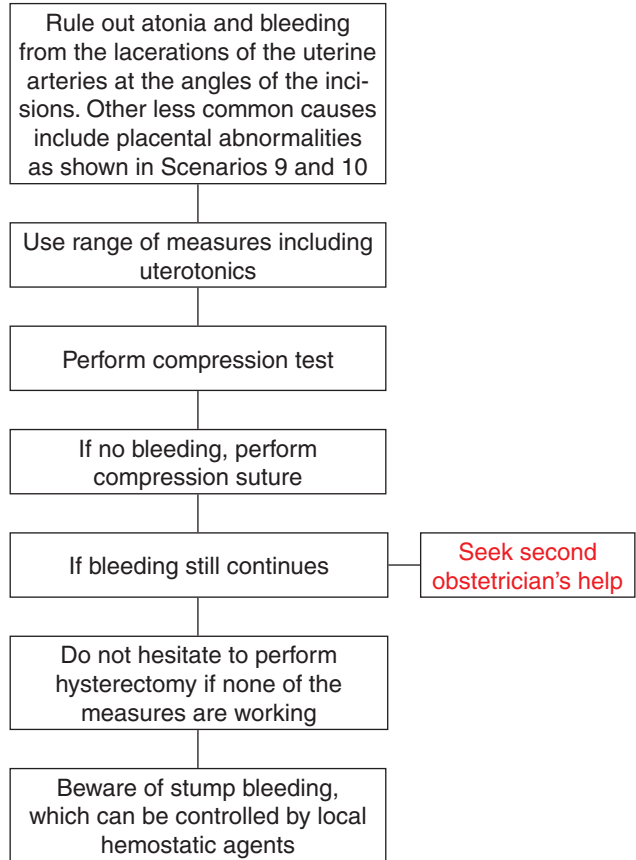
If bleeding is still not under control, then there should be no hesitation to recourse to subtotal hysterectomy. Following any of the above procedures such patients will need care in a high dependency unit (HDU) or intensive care unit (ITU).

Rarely bleeding may continue from the cervical stump (in the case of subtotal hysterectomy) (see Chapter 55) and, in that case, local sealants may be used if available. In difficult cases abdominal/pelvic packing with larger gauzes and closing the abdomen with a view to correcting the coagulopathy and replacing the necessary blood products, and further monitoring in ITU will be required. Once the patient is stabilized, the patient must be returned to theater for removal of the packing.

SCENARIO 4 – EMERGENCY CESAREAN IN THE FIRST STAGE OF LABOR

Bleeding in emergency cesarean sections in the first stage of labor most commonly occurs from atony or lacerations of the uterine artery at one or both angles of the uterine incision. Therapy of uterine atony is well described in Scenario 1 and chapters in Section 8. The bleeding from incisional angles can be controlled by one of two means, both of which are much more easily accomplished when the uterus is exteriorized and held upwards by an assistant.

The first method is to grasp the angle with a non-traumatic forceps and insert one or more figure-of-8 sutures. The second is to examine the lateral margin of the uterus for the uterine artery itself, because the laceration may be in the ascending, middle or descending branch. If circumstances require ligation of the traumatized artery at the lateral margin of the uterus, it is important to place sutures above and below the level of the lacerated angle and include 1–2 cm of the myometrial tissue. This is because the ascending branch of

Rule out atonia and bleeding from the lacerations of the uterine arteries at the angles of the incisions. Other less common causes include placental abnormalities as shown in Scenarios 9 and 10

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Use range of measures including uterotonics

↓

Perform compression test

↓

If no bleeding, perform compression suture

↓

If bleeding still continues → Seek second obstetrician's help

↓

Do not hesitate to perform hysterectomy if none of the measures are working

↓

Beware of stump bleeding, which can be controlled by local hemostatic agents

Scenario 4 – Emergency cesarean in the first stage of labor

the uterine artery anastomoses with the descending branch of the ovarian artery, and the descending branch of the uterine artery anastomoses in turn with the ascending branch of the vaginal artery. The ligation of the uterine arteries is totally without consequence to the uterine function because of the rich anastomotic system that exists. A word of caution is necessary, because if the laceration extends laterally and inferiorly, it is possible to inadvertently include the ureter (Figure 5 and Video 3).
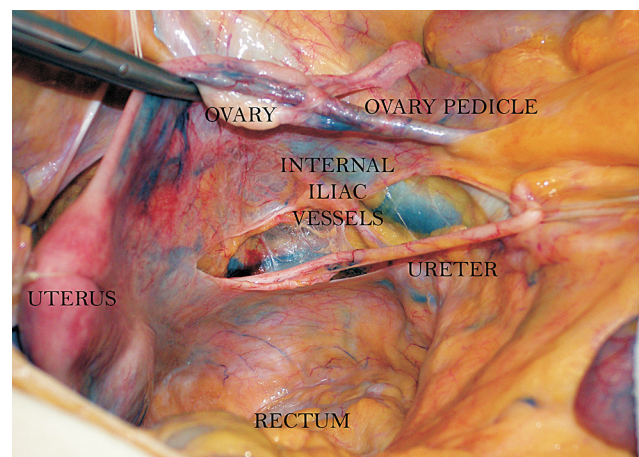

Figure 5 Posterior and right view of female pelvis in a fresh corpse: the image shows the pelvic ureter over the iliac vessels and inside and parallel to the ovary pedicle. Palacios-Jaraquemada, 2012[6], with permission

At the same time as these measures are being carried out, the previously described uterotonic therapy is administered (Scenario 1). Fluid replacement and, if necessary, blood and blood products should also be administered (see Chapters 3–6). If blood is deemed necessary, one should not wait until the laboratory results (hemoglobin, hematocrit, clotting factors, etc.) are present because continued bleeding will lead to coagulopathy[7].

If the uterus appears to be atonic in spite of the uterotonic agents having been administered, bimanual compression of the uterus should be performed with the view to assess the need for placement of compression sutures. It is necessary to be sure that no clotting abnormality is present when the compression test is attempted. Compression should not be performed with the patient in the supine position. Rather, the patient should be placed into the frog-leg position and the uterus should be exteriorized. If the compression test is positive, the operator should place the type of uterine compression suture he/she is most comfortable to perform.

> Surgeons competent to perform cesarean sections MUST also be competent to perform one of the available uterine compression sutures in a timely manner (see Chapters 51–53). The advantage of early compression suture is that the hemorrhage has not extended to the point where clotting abnormalities begin. In the recent article by Palacios describing 539 cases, most surgical hemostatic failures that lead to hysterectomy occurred in women with severe hemodynamic deterioration and coagulopathy[7].

If, in the unfortunate event that none of the above-mentioned interventions are effective and the patient continues with bleeding, a second and senior obstetrician should be called to determine whether hysterectomy is warranted. Here too, it is crucial to have stability within the coagulation system.

If a decision is made to perform a hysterectomy, the subtotal type is faster, equally effective and less likely to be associated with surgical complications such as ureteric injuries. Bleeding may occur from the cervical stump, the side walls of the pelvis, or even the ovarian pedicles. Usually this can be controlled with local hemostatic agents (see Chapters 57 and 58) or with a large pelvic pack consisting of a gauze tube filled with laparotomy pads (Figure 6). If a hysterectomy already has been performed, a plastic bag filled with gauze can be placed in the pelvis with the opening of the bag brought out through the vaginal apex which had been left open (see Chapter 54).

Packing can be removed 24 hours later. Patients who have had this intervention should be observed in the intensive care unit for 24–48 hours to monitor for pulmonary edema and diminished urinary output, pain control and restoration of full clotting parameters.
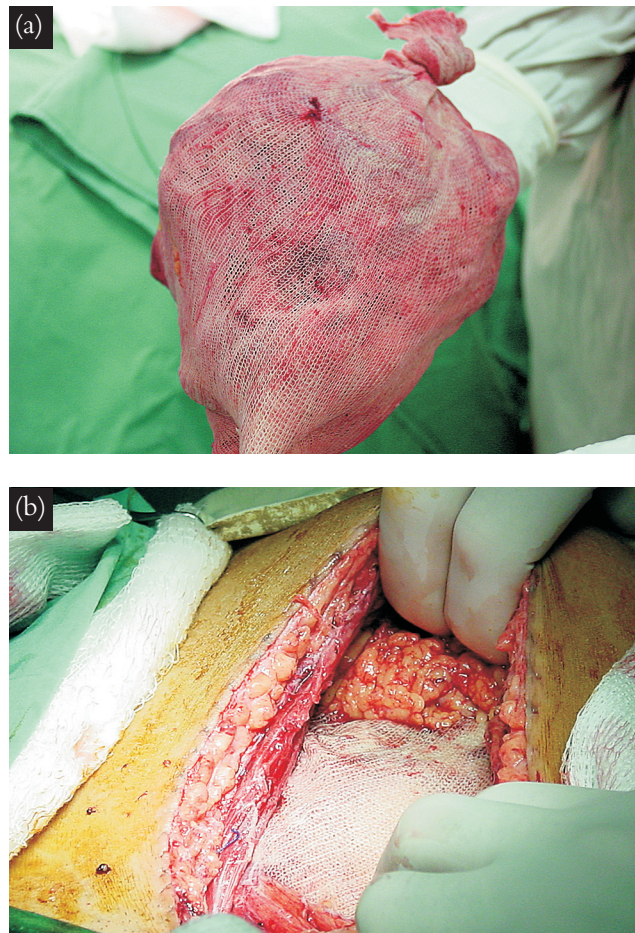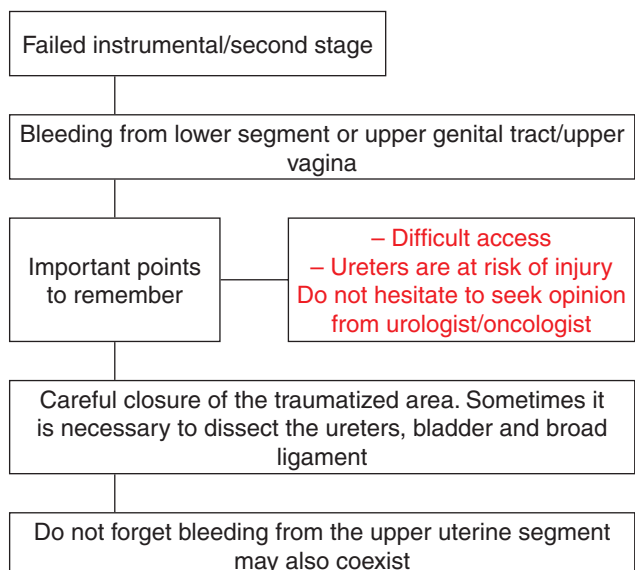
Figure 6 (a) Gauze tube filled with laparotomy pads. (b) Packing with gauze tube filled with laparotomy pads into the pelvis

SCENARIO 5 – FAILED SEQUENTIAL INSTRUMENTAL DELIVERY/EMERGENCY CESAREAN AT SECOND STAGE OF LABOR

Failed instrumental/second stage

Bleeding from lower segment or upper genital tract/upper vagina

Important points to remember

– Difficult access
– Ureters are at risk of injury
Do not hesitate to seek opinion from urologist/oncologist

Careful closure of the traumatized area. Sometimes it is necessary to dissect the ureters, bladder and broad ligament

Do not forget bleeding from the upper uterine segment may also coexist

Scenario 5 – Failed sequential instrumental delivery/emergency cesarean at second stage of labor

Bleeding from failure of an instrumental delivery followed by a difficult fetal extraction during a cesarean is particularly challenging. This is because the source of bleeding could be from atony or the upper genital tract (S1), the lower uterine segment (trauma with or without obvious evidence) or the upper vagina, cervix and parametrium (S2).

The challenges here are to differentiate rapidly which is the most likely cause and whether more than one cause of bleeding is operating concurrently. Time is required to make this differentiation, and the use of intraoperative aortic compression (Video 2) permits the operator to make careful intraoperative assessment in the presence of the markedly reduced bleeding.

Three causative possibilities must be mentioned. The first is that the operator is able to find the traumatized area and place several simple sutures that control the bleeding. In order to do this, the bladder must have been pushed down to make sure that it is protected from getting accidentally included into a suture.

The second is that the operator is unable to control the bleeding from the lower uterine segment or the upper vagina (Video 4). In this case, it is mandatory to dissect the ureter(s) laterally until it (they) enters the bladder. It is not enough to say the operator visualized the ureter, because the traumatized area may actually involve it (Figure 5 and Video 3). At this point, it is helpful to encircle the lower uterine segment with a wide rubber catheter and secure it tightly with a firm clamp placed at its center (Video 5).

The third option relates to trauma at the middle to lower part of the vagina and the levator ani muscle as described below in Scenario 9.

Comments related to proper fluid and blood replacement as described above also apply here.

SCENARIO 6 – ELECTIVE CESAREAN FOR ADHERENT PLACENTA

Unlike the above-mentioned scenarios, this situation requires advanced planning and numerous preoperative measures that start with proper diagnosis, continue to intensive counseling and end with a detailed surgical plan as arrived at by consensus of a multidisciplinary expert team. This team should involve an obstetrician, sonographer, radiologist, interventional radiologist, hematologist, urologist, intensivist and gynecological oncologist (see Chapters 28–30).

Diagnostic consideration of an adherent placenta starts with a thorough history as obtained at the first visit. Important risk factors include prior cesarean delivery/prior repeat cesareans, surgical termination of pregnancy or illegal abortion, curettage and myomectomy. Ultrasound is the key diagnostic aid. It is available worldwide, cheap and can be performed with great accuracy. Placental magnetic resonance imaging (MRI) is reserved for those cases with doubt regarding the degree of invasion or the extent and topography of the invaded area. It is also the only diagnostic tool which will diagnose or rule out parametrial invasion (see Addendum A and Chapters 28–31).
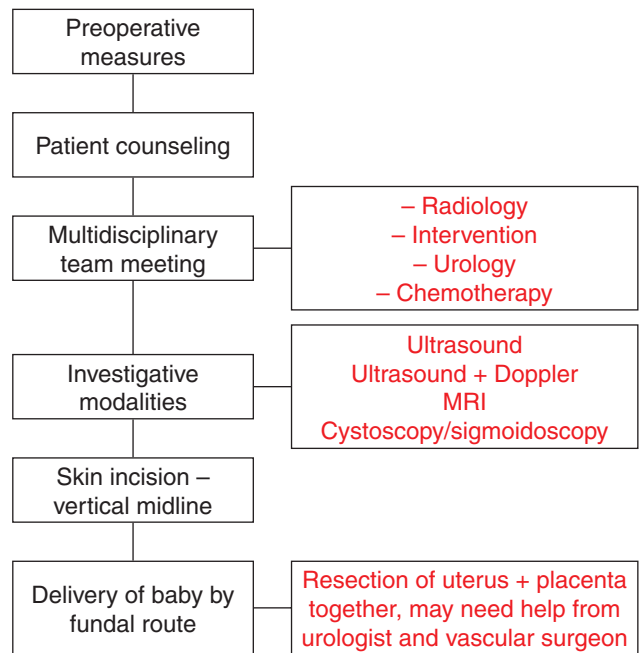
Scenario 6 – Elective cesarean for adherent placenta

Once diagnosis is confirmed, the multidisciplinary team is charged with planning surgery based on the presumed anatomic alterations and the knowledge that the final surgical treatment must be guided by what is found at the time of surgery. Consensus of all team members is optimal, because preoperative diagnosis is invariably less than accurate (see Chapters 28–31).

Controversy exists regarding the proper therapeutic approach when the bladder is invaded. One school of thought proposes leaving the placenta *in situ* even though this may be associated with infectious morbidity; the other advocates performing hysterectomy. Regardless of the decision made, two important factors impinge upon it. The first is whether the woman wants future pregnancies, and the second is the extent of the anatomical abnormalities which can modify any prior decision, i.e., parametrial invasion, bladder invasion, ureteral involvement. Both physicians and patients must recognize that their preconceived plans may not be viewed as realistic during surgery.

Cystoscopy is not useful to determine the extent of bladder invasion; however, it allows insertion of preoperative ureteric catheters.

Providing that the woman has not experienced any antepartum hemorrhage during the present pregnancy, timing of delivery is suggested as follows:

(1) If the placenta is percreta, it is found to involve extensive invasion of the uterine musculature or if parametrial invasion is presumed, then the time of delivery is around 34 completed weeks with antenatal corticosteroids being administered electively.

(2) If the presumed adherent placenta only involves a relatively small area or if invasion through the myometrium is only partial, then elective cesarean delivery is planned around 37 weeks of gestation with steroid coverage.

The time of surgery should be early in the day at the beginning of a week which does not include public holidays. The incision must be midline vertical extending above the umbilicus to the left side so that the baby can be delivered (breech) through a fundal incision (Figure 7).

Once the baby is delivered, the umbilical cord should be cut near to the placental insertion site and the placenta left untouched regardless of whether hysterectomy is planned. One should never try to remove the placenta in such cases, because if bleeding commences, it will be of catastrophic nature within minutes, and circumstances can rapidly become out of control.

If a decision is made to perform hysterectomy, all necessary resources must be on hand. Circumferential suturing is performed around the fundal opening to avoid additional bleeding. Such an operation would require an accurate proximal vascular control such as that provided by aortic or common iliac balloons. This type of vascular control provides hemostasis for both the uterine artery and the lower vascular blood supply (bladder and vagina; S1 and S2 blood supplies) (Figure 8).
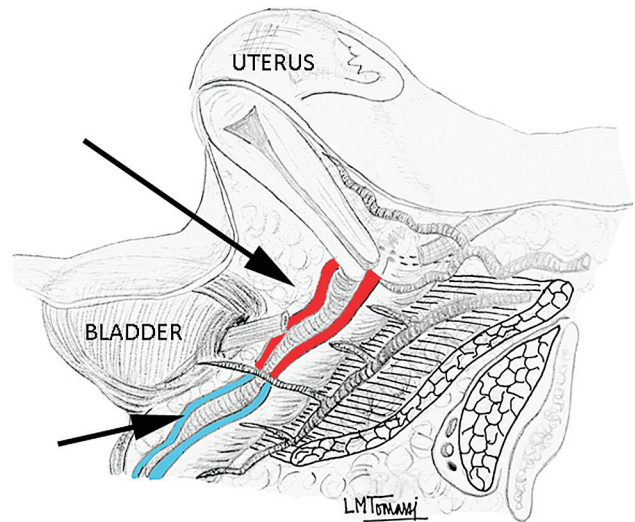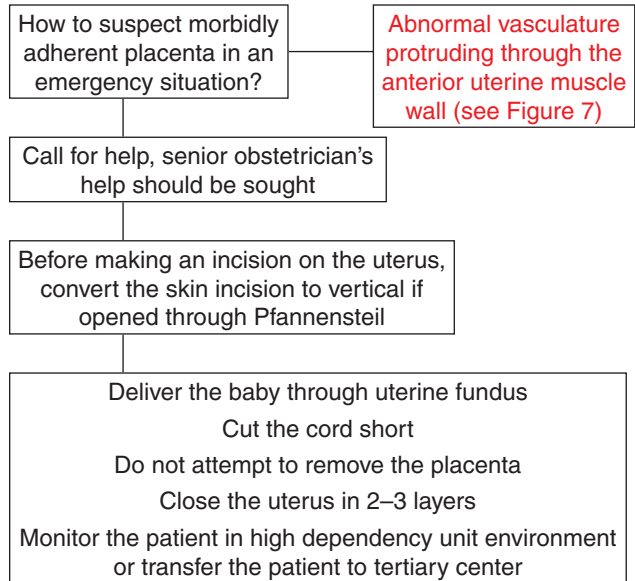

Figure 8   Diagram of access to upper part of vagina

If one decides to perform conservative and restorative surgery as proposed by Palacios-Jaraquemada[8], proceed as described in Chapter 31.

SCENARIO 7 – EMERGENCY CESAREAN SECTION WITH UNEXPECTED DIAGNOSIS OF MORBIDLY ADHERENT PLACENTA

How to suspect morbidly adherent placenta in an emergency situation? — Abnormal vasculature protruding through the anterior uterine muscle wall (see Figure 7)

Call for help, senior obstetrician's help should be sought

Before making an incision on the uterus, convert the skin incision to vertical if opened through Pfannensteil

Deliver the baby through uterine fundus
Cut the cord short
Do not attempt to remove the placenta
Close the uterus in 2–3 layers
Monitor the patient in high dependency unit environment or transfer the patient to tertiary center

Scenario 7 – Emergency cesarean section with unexpected diagnosis of morbidly adherent placenta

Unlike the previous scenario in which the adherent placenta was diagnosed antepartum, the obstetric team must deal with this diagnosis in a state of poor to non-existent preparation when appropriate help is not available or far away. ONCE THE DIAGNOSIS OF ADHERENT PLACENTA IS MADE IN AN EMERGENCY (UNPREPARED) SITUATION, THE OBJECT IS TO DELIVER SAFELY THE BABY THORUGH A FUNDAL INCISION AND LEAVE THE PLACENTA *IN SITU*.

Figure 7   (a) and (b) Fetal delivery through the fundus

The first challenge is to suspect or make the diagnosis. In most instances the visual appearance of the anterior uterine serosa and lower uterine segment at the level of the superior limit of the bladder is sufficient to suggest that something is drastically abnormal. The picture is one of a bulging lower uterine segment with numerous tortuous vessels directly under the serosa or on the peritoneum overlying the bladder (Video 6).

This anatomic distortion is visible immediately upon opening of the peritoneum, especially when a Pfannensteil incision is used. It is important that the obstetrician realize the seriousness of the condition and NOT attempt any manipulations or incisions at this point. Rather, the skin incision should immediately be converted to a vertical incision to the level of the umbilicus or higher in order to have access to the uterine fundus for safe delivery of the baby. Any thoughts of continuing surgery through the Pfannensteil incision should be immediately abandoned, as continuation of surgery will be dangerous and put the mother's life at great risk.

After converting the skin incision and prior to making any uterine incision, help should be requested from the most senior obstetricians and anesthesiologists. In addition, the blood bank should be alerted and samples should be sent for typing and cross-matching.

Delivery of the baby is safest via the fundal route (Figure 7), as this avoids any bleeding complication associated with abnormal placental attachment, especially that which involves the bladder. Once the baby is delivered, the fundal incision can be closed as described in Scenario 6.

Placental delivery should not be attempted in any manner. Similarly, the bladder and its attachments should remain undisturbed, as both can be effectively dealt with at a later time by more experienced personnel with full resources. It is NOT NECESSARY to perform an emergency hysterectomy in this situation.

It is also not necessary to use methotrexate for enhanced placental resorption, because the term placenta has a low level of mitotic activity (less than 1%). However, this statement does not meet with universal agreement.

Even if the patient appears stable after surgery, observation is recommended in a high dependency environment whilst preparations for further care are made.

Additional care at a tertiary center may involve one of three options: first, to leave the placenta *in situ* until spontaneous expulsion or resorption; second, to perform hysterectomy with full resources for the complications that are described in Scenario 6; and third, to perform reconstructive surgery as described in Chapter 31.

SCENARIO 8 – PROGRESSIVE INTERMITTENT PPH

The bleeding in this scenario may follow normal or operative (ventouse, forceps or cesarean) delivery, may commence within a few hours and may last for a few weeks. In other cases, its onset is later (possibly a few days to a week) but its continuation is similar. Because this form of postpartum bleeding is progressive and intermittent, assessment and care may be less than optimal for a number of reasons: (1) failure to keep a running total of the individual episodes of blood loss since delivery or misinterpretation of blood loss as lochia rubra; (2) failure to recognize missing placental cotyledons and/or incompleteness of membranes; and (3) failure to monitor.

The potential gravity of the situation is augmented if the patient's symptoms of dizziness, feeling cold and being weak and tired are ignored or if strict input/output monitoring has not taken place. This latter possibility is more important if the patient has received large quantities of intravenous fluids containing uterotonic agents, and the care givers assume that the situation will correct itself. Other contributing factors include failure to use simple diagnostic aids such as detailed genital examination and/or abdominal and vaginal ultrasound especially after the first 24 hours. The latter may not clearly differentiate between clots and small pieces of retained placental tissue immediately after delivery when the uterus is not fully contracted. Furthermore, the caregiver may underestimate the extent of the blood loss because the patient is hemodynamically stable and her vital signs are well maintained. Finally, if the patient is going to be discharged, she and her family as well as the community health workers or local doctors must be informed about the nature of the small and continuing blood loss. Any patient who leaves the hospital must receive clear and written information about what is considered to be sufficiently abnormal as to require return to the hospital for further care. If she lives a long way from the hospital, she should be given a copy of the discharge summary or some notation as to the nature of the problem and whom to contact with telephone numbers and email addresses if a problem arises.

The following points are provided to ensure optimal follow-up in patients who have intermittent bleeding.

- Intermittent/recurrent bleeding per vaginum following delivery in the first 42 days should be treated as PPH

- Even if the patient's vital signs are stable, it is worthwhile performing an ultrasound scan based on the health center's equipment and resources. If ultrasound is used, it is important to obtain both abdominal and vaginal scans so that the fundal and lower uterine segments can be examined with similar accuracy. If ultrasound scans detect a possible placental segment attachment to a prior cesarean scar, one should be careful with any attempts to remove it manually or by curettage, as such removal may require specialist attention as there is a risk of uterine scar dehiscence, bladder injury or secondary bleeding into the peritoneum

- If possible, the total blood loss from the point of delivery to the current patient encounter should be calculated; do not be afraid to repeat the hemoglobin assessment, if necessary, especially if the patient complains of being tired and weak

- Undocumented blood losses should be carefully assessed, as they may occur with change of bed pans/bed sheets/clothes, or passing of big clots in the toilet pans

- If possible, and if the placenta is still available, it should be re-examined to account for every cotyledon

- If facilities for ultrasound examination do not exist, then examination under anesthesia is required to assess the uterine cavity and remove placental tissue and fragments if they are present. Undetected cervical tears may require simple suturing

- If the operator decides to perform curettage, great care should be exercised to avoid perforation, because the uterine musculature may still be soft and perforations may go unrecognized

- If the bleeding is heavy and intermittent after a few weeks or a month, the most likely diagnosis is not retained placental fragments but PSEUDO-ANEURYSM OF THE UTERINE ARTERY (Figure 9). This condition should be considered when patients have undergone a difficult instrumental delivery, curettage for retained placental fragments, or difficult fetal extraction during a cesarean section. This diagnosis is suspected if the patient has had one, two or more negative ultrasound scans. Diagnostic confirmation is by color Doppler or angiography of the pelvic vessels with the capacity to embolize at the same time. One should not attempt curettage or hysterectomy because the tissues are exceedingly friable and also there is real risk of massive hemorrhage.
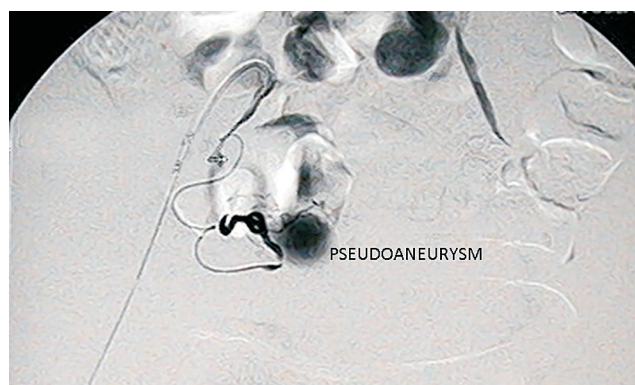
SCENARIO 9 – CONCEALED PPH

Concealed PPH is an important cause of maternal death, because either the clinician is not alerted to its presence until late in its course or the obstetrician is unable to control the bleeding at its source. This scenario presents the relevant material in a more traditional manner, as one algorithm would not fit.

Situations which lead to concealed PPH

- Successful but difficult instrumental delivery causing subperitoneal/retroperitoneal/pre-peritoneal space of Retzius hematoma (Figure 10), injury to the puborectal fascicle or to the external muscular covering of the vagina (Figure 11)

- Failed instrumental delivery leading to emergency cesarean section with or without difficult fetal extraction. (Unsuspected broad ligament hematoma, difficult access to the deep uterine angle

Figure 9 Pseudoaneurysm of the uterine artery – angiography images. Courtesy of Dr Garcio-Mónaco, Buenos Aires, Argentina

extensions, undiagnosed posterior uterine wall injuries, hesitation in closure of uterine angles as the operator is concerned about ureteric ligation and proceeding to close the angles without caution)
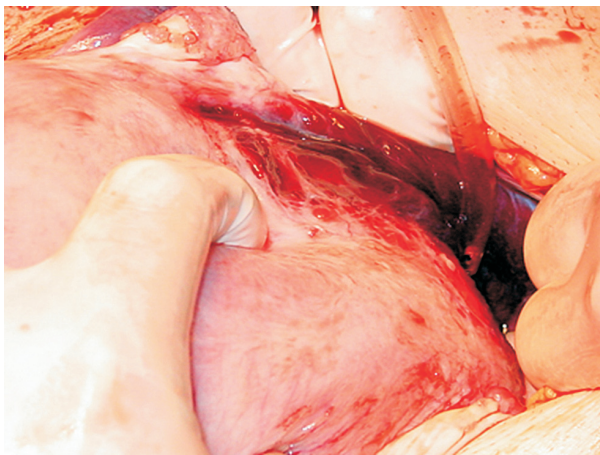
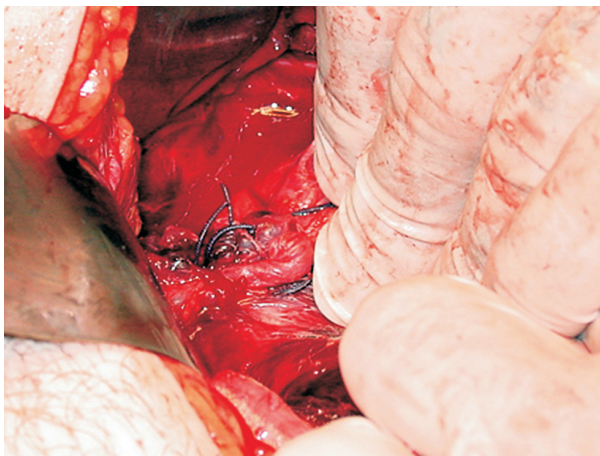**Figure 10**   Retroperitoneal hematoma

Figure 11   Sutured injury of internal fascicle of levator ani muscle

- If elective cesarean is performed in a woman whose cervix was never dilated in the past, she is particularly at risk of uterine atony with the accumulation of a large amount of intrauterine blood clots before clinical deterioration becomes evident. Detection of clinical deterioration may be so late that the patient succumbs despite emergency measures

- Another contributory factor for accumulation of clots after elective cesarean section followed by atony is the lack of response to oxytocic agents, which although uncommon, must be considered. Therapy consists of restoration of uterine tone and expression of the clots

- Uterine rupture can also be easily missed. Classically, such patients are multiparous and their labors have been augmented with uterotonics, induced with prostaglandins, or were precipitate in nature. It is also possible following a midcavity forceps delivery. Such patients are well for a few minutes following delivery, but bleeding continues intra-abdominally without overt deterioration at first. By the time it is recognized, the clinical picture may be grave and resuscitative measures may be futile

- Rectus sheath hematomas, where blood accumulates above the abdominal cavity without

external bleeding, can also cause similar deterioration.

Other contributory factors

- Operator inexperience

- Delivery time of the day with misses more common late at night

- Poor/inexperienced assistant

- Failure to exteriorize uterus to check posterior wall, especially after difficult head extraction

- Operator thinks that small amount of bleeding may diminish over time

- Fast surgery, too much time pressure, too many things to do

- Ignoring clinical signs of deterioration, i.e., worsening tachycardia, falling blood pressure, increasing respiratory rate, increasing abdominal girth, falling urine output and increasing patient demand for analgesic use are all pointers of concealed PPH.

Solutions

- If uterine rupture is suspected, speed and efficiency of the whole team are required. Everyone has a key role starting from the switchboard, to porters, to hematology and blood bank technicians, to midwifery and obstetric and anesthetic teams

- Close monitoring of all patients who need operative intervention is mandatory

- Bedside facilities such as hemoglobin measurement by simple equipment such as Hemacue will aid clinicians rapidly to detect patient deterioration

- Use the modified obstetric early warning scoring system (MOEWS) chart in all at risk patients (see Addendum B of this chapter for a sample chart)

- Education and training of all staff must take place at regular intervals

- Patient counseling must recognize that no cesarean delivery is risk free (either elective or emergency)

- Prompt action by the attending physician is required to establish the cause of a patient's physical deterioration

- From the obstetric point of view, if uterine rupture is suspected and if the patient's situation permits, a bedside ultrasound scan is helpful to diagnose the presence of intraperitoneal bleeding. However, one should also remember not to waste time trying to establish a specific cause, as every second counts in combating situations involving uterine rupture

- If an expanding broad ligament hematoma is suspected, then computed tomography (CT) scanning and embolization of the bleeding vessel has a role. Even if such patients undergo laparotomy, it will be

extremely difficult to identify the exact source of bleeding vessel and tissues will be very fragile.

If patient is taken back for re-laparotomy, what necessary steps should be taken?

- Resuscitation and correction of volume deficiency should happen simultaneously

- It is very easy to miss coexisting coagulopathy; hence there is a high possibility that the patient will require replacement of clotting factors (see Chapters 4 and 6 for discussion of controversy regarding the proper ratio of RBC and fibrinogen products during replacement)

- The team should involve a senior obstetrician with support from another senior obstetrician, senior anesthetist, hematologist and occasionally an intensivist and an interventional radiologist

- During re-laparotomy, meticulous attention should be given to each abdominal layer, and the uterus should be exteriorized and its cavity either checked with intraoperative ultrasound or re-opened. If uterine atony was the cause of patient deterioration, then it may be worthwhile inserting a uterine compression suture or uterine tamponade balloon

- If bleeding is from the uterine parametrium, then one should seek help from the urologist or gynecological oncologist, as the ureters are at risk of being injured while achieving hemostasis

- If time and the situation permit, the patient should be counseled about the risks of hysterectomy. Patients also should be counseled that there is a small possibility of not being able to identify the exact source of bleeding and that even if hysterectomy is performed, bleeding may still continue. In such circumstances, the clinician may decide to put several abdominal packs *in situ* and request further monitoring in the intensive care setting (see above). Once the patient's clinical condition improves, usually after 24 hours, the patient would need another laparotomy to remove the abdominal packs. Occasionally, the patient may still require radiological embolization of bleeding pelvic vessels.

SCENARIO 10 – UTERINE INVERSION AND PPH

Usual scenario

Uterine inversion is almost always secondary to strong traction on the umbilical cord which is attached to the placenta when it is implanted in the fundus. The problem here is not that the placenta is abnormally adherent but rather that the traction is too forceful and too early (before the placenta is normally separated). Inversion can be avoided by simple measures: not attempting the forceful cord traction before the signs of placental separation are seen (lengthening of the cord, fresh gush of bleeding, desire to push by the woman) and placement of one hand on the fundus

while the other hand guides the cord. Of those who experience uterine inversion, one in six women will die if appropriate corrective measures are not applied in a timely manner. Always suspect uterine inversion if the patient becomes shocked immediately after birth without an obvious reason.

Inversion of the uterus may be partial or complete. The upper panel illustrates an incomplete inversion in which the most important physical finding is the presence of a dimple in the uterine fundus. The middle panel demonstrates the three degrees of inversion. In stage '3' and '4', the fundus is completely outside of the vulva, and these two variations are the most catastrophic, as any delay in recognition of the inversion and the urgency of correction may be followed by death of the patient.

Symptoms

The initial symptoms depend upon the severity of the uterine inversion. If inversion is only partial, then severe cramping lower abdominal pain and signs of mild shock, i.e., bradycardia and hypotension, may be the initial signs. Massive bleeding will not be present. On the other hand, if the inversion is complete, it is accompanied by a brief period of neurogenic shock shortly followed by massive PPH. Shock is primarily because of parasympathetic activation of the nervous system because of traction on the peritoneum through ligaments supporting the uterus.

Management

It is imperative that the condition be recognized instantaneously and managed promptly and by the person attending the delivery. The uterus (a dark pink/purple fleshy mass) is observed as lying outside the vulva immediately after birth. If the placenta is still *in situ*, manual repositioning should be attempted without removing the placenta. If separation has not occurred and if the situation is ignored, the patient will bleed massively and possibly precipitate further deep shock.

Help should be called for immediately, as the replacement must be performed with the patient in shock. If the birth attendant cannot immediately replace the fundus and the shock continues, a single dose of atropine (one ampoule) should be administered preferably by the intravenous route to address the neurogenic origin of the shock (parasympathetic blockade).

The initial attempt to replace the uterine fundus entails manual replacement through the vagina past the cervical ring. If the patient is receiving a uterotonic (oxytocin) infusion or is about to receive it as a prophylaxis for third stage bleeding, the infusion should be stopped or withheld whichever is appropriate.

The typical maneuver in repositioning the fundus involves the birth attendant's hand being placed inside the vagina (for stage 3) or on the fundus for stage 4, with the cup of the inverted fundus in the palm of the operator's hand and the tips of fingers directed toward the uterosacral ligaments. The fundus is then forcefully
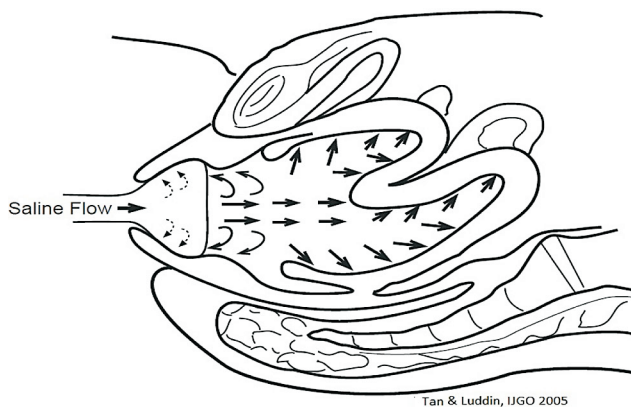
Figure 12 Hydrostatic method of reposition of inverted uterus. From Tan and Luddin, 2005[9], with permission

pushed inside the abdominal cavity above the level of umbilicus and held in that position for 3–5 minutes until the passive action of uterine ligaments corrects the uterine inversion. Care should be taken not to apply so much pressure as to perforate the uterus with the fingertips.

If manual repositioning fails, hydrostatic replacement is the next option. This is carried out using a 6 cm diameter silastic ventouse cup. A good saline seal is crucial for success of hydrostatic reduction. An excellent seal is maintained by pushing the cup to the middle of the vagina and then withdrawing it until it is snugly placed at the vaginal orifice. The accumulating saline will exert pressure backwards to maintain the seal. If necessary, a tocolytic agent can be used to relax any constriction at the level of the cervix. It is important to resist the tendency to push the silastic cup deep inside the vagina (Figure 12).

On occasion, attempts to replace the fundus manually or by hydrostatic pressure fail and the patient must be taken for a laparotomy and surgical correction. A number of measures have been described and are beyond the scope of this chapter. However, one method is found in Chapter 51 by B-Lynch.

Management after successful replacement

As soon as the uterus is restored to its normal position and configuration, it is usual that it remains atonic causing continued massive PPH. Accordingly, a uterotonic infusion is started while the birth attendant maintains the fundus of the uterus in its normal anatomical position. Once this is accomplished, bimanual compression of the uterus aids in control of further hemorrhage until uterine tone is re-established. In some cases, a uterine balloon tamponade may be required. The birth attendant should continue to monitor the uterus vaginally for any evidence of subsequent inversion.

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Addendum A: Guidelines for placental MRIs: technical aspects of MRI scan in morbidly adherent placenta

Like other diagnostic methods placental MRI (pMRI) has certain technical details that can enhance or emphasize its diagnostic accuracy. The main aim of the imaging study is to obtain the best definition of the uterine–placental interphase and its relation to the bladder. Newly formed vessels (NFV) secondary to the development of placenta accreta are under-developed in the middle layer. This particularity requires the pMRI study to be performed with a semi-full bladder, to avoid false negatives as a result of overdistension and/or collapse of the NFV, as well as false negatives due to an empty bladder. It is important that the bladder is only partially full; an empty bladder next to the pubic bone would prevent an adequate sign of the uterine–vesical interphase, resulting in diagnostic error. The use of ultrafast techniques that minimize artifacts produced by fetal movement is rec-ommended. T2-weighted imaging highlights urine as a naturally white contrast, thus allowing better delin-eation of the vesical muscle in relation to the placenta and the underlying myometrium. In the presence of risk factors (multiple D&C, myomectomies or correc-tive surgery), if there are clinical antecedents for the T2 mode allowing a naturally white contrast and a suspicion of posterior placenta accreta, the use of gadolinium is recommended to improve diagnostic accuracy. Without this, a combination of placenta, myometrium, abdominal viscera and the vertebrae form a complex image, which makes an adequate diagnosis of posterior myometrial placental invasion virtually impossible. So far, gadolinium has not shown any side-effects during pregnancy, and there are no toxicity reports. However, and as a precaution, its use is generally recommended for cases in which diagnosis by other techniques is not possible. It is prudent to use pMRI in all cases with a resulting non-conclusive ultrasound or Doppler examination, when it is impor-tant to rule out or confirm the presence of parametrial invasion. Therapeutic options depend on the size of the invasions and exact anatomy of the lesion

Addendum B: Modified obstetric early warning scoring chart

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OBSTETRIC EARLY WARNING CHART.   FOR MATERNITY USE ONLY

NAME: _____   DOB: _____

CHI: WARD:

CONTACT DOCTOR FOR EARLY INTERVENTION IF PATIENT TRIGGERS ONE RED OR TWO YELLOW SCORES AT ANY ONE TIME

Date :					
Time :					
RESP (write rate in corresp. box)	>30				>30
	21-30				21-30
	11-20				11-20
	0-10				0-10
Saturations	90-100%				90-100%
	<90%				<90%
O2 Conc.	%				%
Temp	39 / 38 / 37 / 36 / 35				39 / 38 / 37 / 36 / 35
HEART RATE	170 / 160 / 150 / 140 / 130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50 / 40				170 / 160 / 150 / 140 / 130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50 / 40
Systolic blood pressure	200 / 190 / 180 / 170 / 160 / 150 / 140 / 130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50				200 / 190 / 180 / 170 / 160 / 150 / 140 / 130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50
Diastolic blood pressure	130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50 / 40				130 / 120 / 110 / 100 / 90 / 80 / 70 / 60 / 50 / 40
Passed Urine	Y or N				Y or N
Lochia	Normal				Normal
	Heavy / Foul				Heavy / Foul
Proteinuria	2+				2+
	> 2+				>2+
Liquor	Clear / Pink				Clear/Pink
	Green				Green
NEURO RESPONSE (√)	Alert				Alert
	Voice				Voice
	Pain / Unresponsive				Pain /Unresponsive
Pain Score (no.)	2-3				2-3
	0-1				0-1
Nausea (√)	YES (√)				YES (√)
	NO (√)				NO (√)
Looks unwell	YES (√)				YES (√)
Looks unwell	NO (√)				NO (√)
Total Yellow Scores					
Total Red Scores					