The Role Anesthesiologist in Management of Obstetric Hemorrhage: A Literature Review

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ABSTRACT

Hemorrhagic shock in obstetrics is still a major cause of maternal mortality and morbidity worldwide. Recognition of bleeding in obstetric patients is complicated by the normal physiologic changes that occur during pregnancy. Visual estimates of blood loss are often erroneous and underestimated because of contamination with amniotic fluid, or internal or hidden blood loss. Thus, careful clinical observation and a high index of suspicion are required for the early detection and management of obstetric hemorrhage. The usage of ultrasound (US) is considered as the first line method for detecting abnormal condition which might serve as a predictor for hemorrhagic shock. Despite of careful risk assessment given, obstetric-specific bleeding protocols, such as resuscitation and blood transfusion, are required to facilitate the integration and timely escalation interventions. The intervention of choice for hemorrhagic shock in obstetrics encompasses a wide variety of options, such as the usage of tranexamic acid, cell salvage, resuscitative endovascular balloon occlusion of the aorta (REBOA), anesthetic management, and surgical, as well as radiological provides multiple available approach, each with their own risk and advantages. The purpose of this review is to describe the management of obstetric hemorrhage from anesthetic point of view, encompassing the identification of patients at risk, resuscitative management, and perioperative management.

Keywords: *a*nesthesia management; hemorrhagic shock; obstetric hemorrhage; perioperative management; pregnancy

Peran Anestesi dalam Manajemen Perdarahan Obstetri: Tinjauan Literatur

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ABSTRAK

Syok hemoragik pada kebidanan masih menjadi penyebab utama kematian dan kesakitan ibu di seluruh dunia. Pengenalan perdarahan pada pasien kebidanan diperumit oleh perubahan fisiologis normal yang terjadi selama kehamilan. Perkiraan kehilangan darah secara visual sering keliru dan diremehkan karena kontaminasi dengan cairan ketuban, atau kehilangan darah internal atau tersembunyi. Dengan demikian, pengamatan klinis yang cermat dan indeks kecurigaan yang tinggi diperlukan untuk deteksi dini dan pengelolaan perdarahan obstetrik. Penggunaan ultrasound (US) dianggap sebagai metode lini pertama untuk mendeteksi kondisi abnormal yang dapat berfungsi sebagai prediktor syok hemoragik. Terlepas dari penilaian risiko yang diberikan secara hati-hati, protokol perdarahan khusus obstetri, seperti resusitasi dan transfusi darah, diperlukan untuk memfasilitasi integrasi dan intervensi eskalasi yang tepat waktu. Intervensi pilihan untuk syok hemoragik dalam kebidanan mencakup berbagai macam pilihan, seperti penggunaan asam traneksamat, penyelamatan sel, oklusi balon endovaskular resusitasi aorta (REBOA), manajemen anestesi, dan bedah, serta radiologi memberikan beberapa pendekatan yang tersedia, masing-masing dengan risiko dan keuntungannya sendiri. Tujuan dari tinjauan ini adalah untuk menjelaskan pengelolaan perdarahan obstetri dari sudut pandang anestesi, meliputi identifikasi pasien yang berisiko, manajemen resusitasi, dan manajemen perioperatif.

Kata Kunci: *kehamilan; manajemen anestesi; manajemen perioperative; perdarahan obstetric; syok hemoragik*

INTRODUCTION

Major obstetric hemorrhage refers to any type of excessive bleeding, usually related to pregnancy, in the mother giving birth. Causes of obstetric hemorrhage have traditionally been classified as antepartum and postpartum, referring to the timing of maternal bleeding in relation to fetal delivery.[1,2] The presence of coagulation disorders, either congenital or acquired, can further contribute to the incidence and severity of obstetric hemorrhage. They are include placenta previa, uterine rupture, placental abruption, uterine atony, placenta accreta, and genital trauma.[1,4,5] American Congress of Obstetricians and Gynecologists (ACOG) defines maternal hemorrhage as a cumulative blood loss greater than or equal to 1,000 mL or blood loss accompanied by signs or symptoms of hypovolemia within 24 hours after the birth process, remains the leading cause of maternal mortality worldwide.[6] Specifically, in the case of labor, postpartum hemorrhage was defined as 500 ml estimated blood loss with vaginal delivery and more than 1000 ml estimated blood loss with cesarean delivery. [2,5]

Hemorrhagic shock in obstetrics is still a major cause of maternal mortality and morbidity worldwide.[7] In developing countries, including Africa and Asia, peripartum hemorrhage is responsible for 30% of all direct maternal deaths. [8] Despite advances in obstetric and transfusion medicine, well-resourced countries cannot avoid this potentially catastrophic complication, with peripartum hemorrhage accounting for 3.4% and 11.8% of maternal deaths in the UK and the US, respectively.[2,9,42]

Recognition of bleeding in obstetric patients is complicated by the normal physiologic changes that occur during pregnancy. Mean blood pressure usually declines 4 to 6 weeks after conception, mainly due to maternal systemic vasodilation and, to a lesser extent, from high-flow, low-resistance circuits in the uteroplacental circulation.[7] Later in pregnancy, during the second trimester, blood pressure tends to rise to normal levels. In addition to hemodynamic changes in vascular tone and resistance, circulating blood volume increases by as much as 40% to 50% above nonpregnant volume, further confounding the diagnosis of acute hemorrhage.[10] Further visual estimates of blood loss are often erroneous and underestimated because of contamination with amniotic fluid, or internal or hidden blood loss. Thus, careful clinical observation and a high index of suspicion are required for the early detection and management of obstetric hemorrhage.[3]

Obstetric-specific bleeding protocols, facilitating the integration and timely escalation of pharmacological, radiological, surgical, and transfusion interventions, are critical to the successful management of peripartum hemorrhage. These protocols are rapidly changing and require a multidisciplinary approach. This review article is meant to be an evidence-based review of management in obstetric hemorrhage from obstetric anesthesia point of view.

IDENTIFICATION OF PATIENTS AT RISK FOR OBSTETRIC HEMORRHAGE

Surgeons and anesthesiologists must identify patients at risk for peripartum blood loss and hysterectomy to prepare a multidisciplinary strategy, including massive transfusion protocols, embolization, arterial ballooning, and finally, hysterectomy.[11,12] Ultrasound (US) is considered the first-line method for detecting abnormal placentation in the prenatal period. Anterior placentation or cesarean scar was previously identified as an independent factor for transfusion and hysterectomy in a retrospective study. [13,14] Baba *et al*. reported three independent risk factors associated with blood transfusion in patients with placenta previa: a) lacunae (hypoechoic areas of the placenta) representing abnormal placental adhesions on imaging, b) previous CS, and c) placenta covering the previous CS scar, indicating an anterior or central placenta. Chen *et al*. developed a scoring system for predicting massive postpartum transfusion that considers the following five factors: a) suspected placental adhesion on imaging (2 points), b) previous CS (0, 1, >2: 0, 1, and 2 points, respectively), c) gestational age below 37 weeks (1 point), d) anterior placenta (1 point), and e) spongy appearance of the cervix (1 point). They demonstrated that the combination of clinical

features and suspicion of placental invasion was more predictive than suspicion of placental adhesions alone. Delivery in patients with 4 of 7 points, represents a 72% chance of massive transfusion. Magnetic Resonance Imaging (MRI) may also be used when US findings are inconclusive, especially in women with abnormal placentation. In systematic reviews and meta-analytical reports, MRI is highly accurate for detecting the presence of placental invasion, depth, and topography. Furthermore, MRI and US showed similar performance in detecting the presence of invasive placentation.[11]

SPECIFIC RESUSCITATION OF OBSTETRIC HEMORRHAGE

Common etiologies of postpartum hemorrhage are uterine atony, retained placental tissue, and genital tract trauma. Less commonly, congenital coagulation disorders can cause or contribute to bleeding. Evaluation of a systematic inspection of the cervix, vagina, labia, and perineum should be performed after each delivery.[12] Subsequent problems can be avoided by proper detection and repair of lacerations of the lower genital tract before the patient leaves the delivery room. Uterine rupture is a serious cause of postpartum hemorrhage. Due to the increasing number of cesarean sections in many parts of the world, rupture of the previously injured uterus is becoming more common, as are varying degrees of placenta accreta.[15,16]

When uterine atony is the main cause of obstetric hemorrhage, most guidelines recommend temporary mechanical measures, such as uterine massage or bimanual uterine compression, in conjunction with pharmacological treatment. Uterotonic is considered the first line of treatment for uterine atony.[16] Intravenous oxytocin is usually the recommended drug and route of administration, but the dose varies widely. When oxytocin fails to control PPH, guidelines recommend the use of additional medications, such as ergot alkaloids, injectable prostaglandins, or misoprostol.[12] The Society of Obstetricians and Gynaecologists of Canada (SOGC) identifies carbetocin as an available uterotonic for treatment, and the German/ Austrian/Swiss guidelines emphasize that there is currently insufficient investigation into the use of carbetocin for treating postpartum hemorrhage (PPH). WHO has updated this topic and recommends the use of TXA, as soon as possible, within the first 3 hours of birth, at a dose of 1 g intravenously, regardless of the route of delivery.[16] However, some guidelines still do not recommend this due to a lack of validation evidence. Another drug has been discussed in some guidelines for activated recombinant factor VII for massive PPH. However, there is no consensus on its usefulness.[15] When pharmacological treatment fails to control bleeding, the guidelines usually recommend several mechanical, radiological, and more conservative surgical approaches before performing a hysterectomy.[16] The most cited are the use of uterine balloon tamponade (UBT), uterine compressive suture (UCS), pelvic vascular ligation (PVL), and embolization. Uterine compression with gauze is also mentioned in some guidelines, but its use is controversial. ACOG recommends the use of gauze moistened with thrombin. UBT is usually indicated as the treatment of choice when uterine atony is refractory to uterotonics following vaginal delivery because it is less invasive than other procedures.[12,16]

Severe postpartum hemorrhage is most commonly encountered when the normal mechanisms for uterine contraction after delivery of the fetus and placenta fail. Initial pharmacotherapy of uterine atony should be intravenous oxytocin infusion at a rate of at least 50 mU/min combined with manual uterine compression and massage. Compressions are easy to do when the stomach is opened at cesarean section. Placing one hand in a Douglas pouch and wrapping the finger firmly around the lower uterine segment and its broad ligaments can provide a degree of uterine artery narrowing while the other side compresses the fundus directly. When the abdomen is closed, the uterus should be anteflexed and pressed by the examiner with one hand behind the cervix and the other against the abdominal wall.[17,43]

The use of ergot derivatives may be considered when oxytocin and uterine compression are ineffective. These drugs may not be used if the patient is hypertensive or hemodynamically unstable. Further drug therapy can be carried

out with 15-methylated analogs of prostaglandin F2α. This drug (carboprost tromethamine) is effective in most cases of atony unresponsive to other therapies. Many patients respond with one or two doses given intramuscularly at 15-45 minutes intervals. Side effects include 10-25% incidence of gastrointestinal symptoms and approximately 5% incidence of pyrexia. The drug is contraindicated in women with cardiovascular and pulmonary disease because of the potential hypertensive and bronchoconstrictor effects. In Europe, sulprostone (a prostaglandin E2 analog) has been used because it has a relatively specific effect on uterine smooth muscle. Pharmacotherapy can also be approached with the use of off-label misoprostol. When administered intrarectally at doses of 800-1000 g systemic absorption appears to be relatively rapid and may be effective in controlling bleeding in some cases of atony.[17,43]

Treatments to save the uterus include uterine dressings (plain gauze or gauze moistened with vasopressin, chitosan, or carboprost [Hemabate]), arterial ligation, uterine artery embolization, B-lynch compression sutures, and balloon tamponade. Balloon tamponade (in which direct pressure is applied to the potential bleeding site through a balloon inserted through the vagina and cervix and inflated with sterile water or saline), uterine dressings, aortic compression, and nonpneumatic antishock clothing may be used to limit bleeding while definitive treatment. The use of a Sengstaken-Blakemore tube, or capacity (3-400 mL) urological balloon may be considered whenever pharmacotherapy is ineffective. This approach may produce a similar effect to uterine dressings but is more effective and easier to use, and makes hysterectomy unnecessary.[18]

When persistent postpartum uterine bleeding does not respond to standard therapy adequately, but the patient is hemodynamically stable and can tolerate 1-2 hours until bleeding is controlled, angiography should be considered before surgical intervention. The catheter is inserted by the radiologist into the abdominal aorta and an aortogram is taken to locate the distal bleeding site. The catheter is directed into the affected vessel or the internal iliac artery, and blood flow is stopped by embolization.[18]

BLOOD TRANSFUSION

The loss of blood volume, relative to normal blood volume respective towards each patient's age (70 ml/kg in adults with ideal body weight, 60 ml/kg in elderly, and 80–90 ml/kg in children), within 24 hours defined as massive blood loss. Another alternative definition is the loss of 50% of blood volume within three hours or a rate of loss greater than 150 ml per minute. Massive hemorrhage in non-trauma patients can be caused by such things as gastrointestinal bleeding, rupture of abdominal aortic aneurysm, as well as bleeding caused by surgical or obstetrical procedures. A massive transfusion procedure (MT) is determined by the volume of blood products transfused, as well as the time frames of the procedure.[19] The three most common definitions of MT in adults are: (i) transfusion within 24 hours of ≥ 10 red blood cell (RBC) units, which approximates the total blood volume (TBV) of an average adult patient; (ii) transfusion of more than 4 RBC units within one hour with anticipation of the continued need for blood product support; and (iii) replacement of more than 50% of TBV by blood products within three hours. In the pediatric setting, MT can be defined by the volume of blood products transfused relative to the estimated total blood volume for a child over a 4, 12, or 24-hour period. Although, a new study regarding children's treatment in a combat environment indicated that 40mL/kg transfused within 24 hours yielded the highest sensitivity and specificity in identifying critically injured children at risk for death at any point after 24 hours.[9,42]

Massive transfusion protocols should be implemented to address the preoperative preparation of blood components and intraoperative management due to blood product transfusion is generally considered for massive preoperative bleeding.[19,20] Ideally, cross-matched blood products should be administered to patients with obstetric hemorrhage, although, in the case of unavailability of certain blood and patients, O-negative blood can be used.[20,21] It is recommended to use a 1:1 ratio of PRC to FFP in crystalloids and colloids infusion due to avoid the risk (e.g. dilutional coagulopathy, metabolic acidosis, tissue edema, hypothermia, and

tissue hypoxia) with large amounts of infusion. Increased plasma and platelet ratio (PLT) have been associated with improved outcomes in traumatically injured patients, although the optimal ratio for resuscitation remains unknown. It is suggested in a recent study on traumatically injured civilian adult patients that a transfusion of plasma, PLTs, and RBCs in a 1:1:1 ratio had reduced death by exsanguination, compared to those receiving a 1:1:2 ratio, although the overall mortality between the two groups was not different.[9,42] During the ongoing transfusion, there are several parameters to measure in 30-60 minutes as shown in Table 1.

Tabel 1. Parameters to be checked during transfusion[41]

Parameters	Values to aim for
Temperature	36-37°C
Acid-base status	pH >7.2, base excess <–6, lactate <4 mmol/L
Ionized calcium (Ca)	>1.1 mmol/L or >7.5mg/dL
Haemoglobin (Hb)	This should not be used alone as a transfusion trigger; and, should be interpreted in context with hemodynamic status, and organ & tissue perfusion.
Haematocrit (Hct)	>24%
Platelet (Plt)	≥ 50 x 109 /L (>100 x 109 if head injury/ intracranial haemorrhage)
PT/APTT	≤ 1.5x of normal
Fibrinogen	≥ 1.0 g/L

The goal of massive transfusion protocols (MTP) is to rapidly provide blood products to hemodynamically unstable bleeding patients and to treat coagulopathy, including the availability of blood products in a predefined ratio and its rapid transport and transfusion. Lower mortality, lower risk of multi-organ failure, higher rate of fascial closure, and decreased use of blood products have been found in trauma patients with MTP implementation. Other goals of MTP are the recognition of blood loss, maintenance of tissue perfusion and oxygenation by restoration of blood volume and hemoglobin (Hb), arrest of bleeding in combination with the use of early surgical or radiological intervention, and judicious use of blood component therapy to correct coagulopathy.

Several risks and complications of MT might include respiratory complications (TRALI/ TACO), renal insufficiency and failure, abdominal complications, and other transfusion-related complications, as well as multisystem organ failure. Complications can manifest in various ways. These may include volume overload, requiring careful monitoring of filling pressures, response to volume, diuresis, etc. Over-transfusion is another concern, necessitating regular monitoring of hemoglobin levels and titration according to needs. Hypothermia is a risk, and it is essential to monitor temperature, use fluid warmers, and employ other measures to reduce heat loss. Dilutional coagulopathy of clotting factors and platelets requires regular and early monitoring of coagulation, with the involvement of hematology for replacement therapy. Transfusion-related acute lung injury is a potential complication, and it is advisable to consider the use of a filter and leukodepletion. Excessive citrate causing metabolic alkalosis and hypocalcemia can occur, making it important to monitor pH and ionized calcium and replace calcium as necessary. Hyperkalemia is a risk that may require the use of younger blood, regular monitoring, and specific therapy if necessary. Disease transmission, such as bacterial or viral infection, is a concern, emphasizing the need to use blood products only when necessary and to follow standard blood banking precautions. Other complications, such as graft-versus-host disease (GVHD) in case of uncross-matched / O negative blood, the hemolytic reaction of newborn with RhD mismatch (acute/delayed or non-febrile), difficulty with cross-matching future blood product, difficulty with matching

solid organs, and logistical issues. Anaphylaxis warning must be kept in mind if IgA is deficient and storage lesion effects. These problems might be a distraction that results in not controlling the hemorrhage source, hurried cross-checking and incompatibility, and other problems such as loss of identity, crossmatching issues, and loss of baseline hematological information, etc.

THE ROLE OF TRANEXAMIC ACID

Tranexamic acid (TXA) is a synthetic analog of lysine. Tranexamic acid has an antifibrinolytic effect and WHO recommends it be given in cases of postpartum hemorrhage. Tranexamic acid should be administered within 3 hours of vaginal or cesarean delivery.[3,22] Tranexamic acid is recommended by International Federation of Gynaecology and Obstetrics (FIGO) to be administered as soon as possible after postpartum hemorrhage is established within 3 hours of delivery. If more than 3 hours postpartum, there is no strong evidence for the administration of tranexamic acid. The recommended administration of tranexamic acid is 1 g IV given within 10 minutes between 3 hours after vaginal or cesarean delivery.[22] Administrating of tranexamic acid that is too fast (>1 ml/min) can cause hypotension, so slow infusion is necessary. If bleeding continues after 30 minutes of administration or stops and resumes within 24 hours of the first dose, a second dose of 1 g may be given. Tranexamic acid is a strategy that can be used in the management of postpartum hemorrhage and has been validated in several trial studies.[22] Tranexamic acid is recommended for all women with clinically estimated bleeding of more than 500 ml after vaginal delivery or 1000 ml after cesarean delivery, or any blood loss sufficient to cause hemodynamic compromise, regardless of the cause of the bleeding.[22] Tranexamic acid forms a reversible complex that interferes with plasminogen to form fibrin resulting in an inhibitory effect on fibrinolysis and inhibition of the proteolytic activity of plasmin.[15,23]

FIGO recommends that TXA should always be available in obstetric care facilities. Due to the advantages of being cost-effective, temperature stable, and widely available with a long shelf life. An economic evaluation using data from the WOMAN trial to assess the cost-effectiveness of initial TXA for the usual care of women with PPH in Nigeria and Pakistan concluded that it is likely to greatly save cost. TXA should be used in addition to all the usual treatments for PPH management including medical (uterotonic), nonsurgical, and surgical interventions. This drug has a broad therapeutic index, and further intravenous injections may be given if possible. Alternative routes of administration should be a research priority, as recommended by WHO. Because of improvements in emergency obstetric care, including the use of TXA as first-line therapy, more women will survive PPH than ever before. Along with that, the incidence of PPH will increase, and consequently, the number of women who will experience its physical and psychological consequences will also increase.[15]

SURGICAL INTERVENTION OF OBSTETRIC HEMORRHAGE

Surgical intervention is often required to treat obstetric hemorrhage. The chosen intervention will depend on the cause of the bleeding, the experience of the treating team, and hospital regulations. The usual interventions are manual removal of the placenta, uterine packing, intrauterine balloon tamponade (Bakri/Rusch balloon, Foley's/condom catheter, Sengstaken-Blakemore tube), uterine compression sutures (B lynch sutures), pelvic vessel ligations (internal iliac, uterine, hypogastric, or ovarian arteries), uterine and hypogastric artery ligation, interventional radiology (intraarterial balloon occlusion and arterial embolization), and hysterectomy.[3,24,25]

RADIOLOGICAL INTERVENTION OF OBSTETRIC HEMORRHAGE

Interventional radiology is often used for cases of anticipated or unanticipated obstetric bleeding. A catheter with a balloon at the distal end is placed in the uterine or iliac artery; The balloon can be inflated prophylactically during a surgical procedure (after delivery of the fetus in the case of cesarean section), or whenever necessary. Once the bleeding is controlled, the balloon can be deflated, the catheter removed, and alternatively, arterial embolization (with

gel foam, glue, roll, or other particles) may be performed if the bleeding is not controlled.[26,27] This procedure can avoid a cesarean hysterectomy, and preserve fertility.[3]

CELL SALVAGE

Cell Salvage is an attractive option for managing obstetric hemorrhage, but some issues make this modality controversial. There is a possibility of maternal alloimmunization, mixing of blood with amniotic fluid, and cell debris. Moreover, such a modality can be useful only if 24-hour emergency services are available. Cell Salvage may be useful in women experiencing obstetrical bleeding due to conditions such as placenta previa, accreta, abruption, and uterine rupture.[28] This method can also be given to women in labor with severe anemia, rare blood types, and refusal of blood transfusions.[1,29]

A recent study concluded that this modality has an "acceptable safety profile and should be considered when treating patients at high risk of obstetric bleeding and transfusion." The American College of Obstetricians and Gynecologists recommends this modality in patients who experience severe bleeding due to postpartum hemorrhage. The American Society of Anesthesiologists supports its use in post-partum bleeding when blood is not available or in cases where the patient refuses stored blood.[3]

RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA MANAGEMENT

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is one of the techniques used especially in trauma settings. Formerly used for military emergency purposes, this minimally invasive procedure had improved and expanded into civilian trauma cases. The concept of REBOA is used to occlude the aorta and decrease blood flow temporarily.[30] The concern of the Obstetrician regarding obstetric hemorrhage was maintaining arterial pressure and reducing blood transfusion requirement. Thus, the utilization of this procedure had increased over the years for obstetrical patients. This technique used to be utilized for military emergency purposes, although currently, this procedure had improved and expanded to civilian trauma cases too. Its concept is to occlude the aorta and decreased blood flow temporarily.[31] While the main concern of obstetricians regarding obstetric hemorrhage was maintaining arterial pressure and reducing blood transfusion requirement. Thus, the utilization of this procedure had increased over the years in the obstetrical setting.

According to Loffe *et al*. and Schol *et al*., the utilization of REBOA produced significant reductions in the requirement of packed RBC transfusion, while also decreasing estimated blood loss. Two systematic reviews and meta-analysis showed that prophylactic action using this procedure tend to stabilize obstetric bleeding. The consequences of EBOA to the fetus and newborn have not been reported, but according to Ordonez, et al., there is no significant difference in APGAR score. Overall, the perspective regarding REBOA utilization on obstetric hemorrhage tends to be viable, safe, and effective.

ANESTHETIC MANAGEMENT

Anesthetic management requires careful preoperative planning. Important management factors include: optimization of hemoglobin, adequate intravenous access, availability of rapid infusion, monitoring of hemodynamic factors (including central and peripheral arterial and venous access), rapid availability of blood products, compression stockings, positioning to prevent nerve compression, and hypothermia treatment and prevention.[32]

Regional or general anesthesia may be used depending on the anticipated blood loss, and the amount of bleeding and the duration of the procedure. Regional anesthesia can provide better postoperative pain control, reduce the risk of aspiration, reduce bleeding, allow for better mother-infant bonding, and reduce fetal exposure to drugs.[33] Disadvantages include the risk of hemodynamic instability. In addition, potentially simultaneous management of the airway during surgery is an undesirable situation.[17,43]

According to the scoring system consisting of the five factors mentioned above, an index score below 3 out of 7 points is considered a low risk of massive bleeding (44% probability of massive transfusion) and, since most cases are

hemodynamically stable, regional anesthesia is preferred. [34] An index score of more than 4 points indicates a high risk of massive bleeding for which general anesthesia and central venous catheterization should be considered in preparation for a massive transfusion, defined as a transfusion of 8 units of red blood cells. [4,8,34] If a mother giving birth with obstetric bleeding requires anesthesia for surgical intervention, then the main concern is the need for rapid and efficient resuscitation, ensuring the well-being of the baby and mother, even though the mother comes first. Adequate noninvasive and invasive hemodynamic monitoring is essential. In hemodynamically unstable pregnant women, general anesthesia is the preferred technique, there may be problems with the airway and the effect of anesthesia on the fetus should always be considered. Regional anesthesia is always preferred in laboring women; however, coagulopathy may be a contraindication to regional anesthesia.[35] Ketamine and etomidate are the induction agents of choice in unstable patients. It is very important to monitor these patients after surgery in intensive care until they are hemodynamically stable.[16]

The role of preoperative anesthesia evaluation was very crucial, regardless of emergency or elective operation. There are several principles to prevent obstetric hemorrhage, such as: (1) avoidance of prolonged labor, (2) minimal trauma during assisted vaginal delivery, (3) detection, and treatment of anemia during pregnancy, (4) MRI to determine placenta accreta/percreta, and (5) third stage labor active management [early clamping of umbilical cord, controlled cord traction, and prophylactic uterotonic agent, and long-acting oxytocin derivative (carbetocin)]. On the other hand, a modified early obstetric warning system (MEOWS) could be a useful tool to track maternal physiological parameters, resulting in increased awareness for early recognition and treatment. All these principles on perioperative prevention of obstetric hemorrhage must be organized with a multidisciplinary team, especially the obstetrician operator.

ANESTHESIA PREOPERATIVE MANAGEMENT

The role of anesthesiologists in preoperative management of obstetric hemorrhage was identified as risk factors and further treatment before surgery. There are several special attentions on hemoglobin levels, coagulation studies, blood grouping, and cross-matching. Assessment of intravascular depletion also needs to be concerned in obstetric patients. Signs of hypovolemia such as hypotension, heart rate > 120 beats/minute, urine output production <0.5 cc/kg/minute, and capillary refill time should be monitored.

Other than observing the physiological baseline of obstetric patients, utilization of interventional radiology should be considered to decrease massive hemorrhage events, especially in placenta accreta patients. Once the hemodynamic is stable, the anesthesiologist could assist the patient to the radiology department for angiographic occlusion balloon catheters. One of the procedures (REBOA) for balloon catheter occlusion could be utilized.

ANESTHESIA INTRAOPERATIVE MANAGEMENT

When massive hemorrhage has been predicted, anesthesiologists need to consider the utilization of anesthetic techniques. Spinal anesthesia through a complete sympathectomy mechanism could impair the ability to vasoconstrict and increase systemic vascular resistance. This sympathectomy mechanism could worsen the hemorrhage event and impact the patient's hemodynamics. To avoid those conditions, anesthesiologists should change the spinal anesthesia technique into regional anesthesia with a continuous epidural technique which is safer and more appropriate for patients with placenta accreta.[33]

Blood conservation is also needed by anesthesiologists to prevent massive uncontrolled hemorrhages.[36,37] There are several techniques for blood conservation such as hemodilution technique and intraoperative cell salvage. The hemodilution technique that is often used is acute normovolemic hemodilution where blood is taken from the central line, then collected into a citrated blood bag. 500-1000 mL of blood will be taken, then simultaneously replaced with colloid (1:1 ratio) or crystalloid (1:3 ratio) fluids to keep the patient's hemodynamics stable.[36,37] When

intraoperative bleeding occurs and the source of bleeding has been controlled, the previously collected blood is returned to the patient. The blood that has been drawn can be reused by the patient up to 6 hours after collection. In addition to hemodilution, intraoperative cell salvage can also be performed where blood from the operating area is collected and then returned to the patient. Blood is collected using suction and then filtered to remove molecules such as tissue factor, alpha-fetoprotein, platelets, and circulating procoagulant.

When various bleeding prevention mechanisms are felt to be inadequate, the anesthesiologist may consider implementing a massive transfusion protocol.[36] Considerations of massive transfusion can be made if there is active bleeding, accompanied by the following conditions (1) systolic blood pressure <90 mmHg, (2) pH <7.1, (3) base deficit > 6 meq/L, (4) temperature below 34°C, (5) INR > 2.0, and (6) platelet count < 50,000/mm3. Once the protocol is activated, the blood bank will send round 1 protocol transfusions (6 units PRBC, 6 units FFP, 6 units platelets, and 10 units cryoprecipitate), then if the bleeding has not stopped, the blood bank will send a round 2 protocol transfusion (6 units PRBC, 6 units FFP, and 20 units cryoprecipitate) in the final stage, if the bleeding has not stopped, recombinant activated factor VII (40 micrograms/Kg) can be given.[38] As soon as the bleeding stops, the blood bank needs to be informed so that the protocol can be stopped.

ANESTHESIA POSTOPERATIVE MANAGEMENT

In patients who have undergone massive obstetric bleeding, complications often occur in the form of thromboembolism (deep vein thrombosis). If after surgery there is still suspicion of bleeding, mechanical prophylactic measures can be carried out. Once safe, pharmacological prophylaxis can be given.[39]

It is not uncommon for patients to manifest oliguria and hypotension after massive resuscitation. In general, the treatment that can be given is to give fluids, but it needs to be considered where abdominal compartment syndrome can occur. Abdominal compartment syndrome can occur resulting in pressure on the abdominal and retroperitoneal vessels and impairing cardiac preload. These conditions can significantly lead to hemodynamic disturbances which are characterized by decreased cardiac output and disturbances in blood pressure.[33]

MONITORING OF PATIENTS WITH OBSTETRIC HEMORRHAGIC

Patients with obstetric bleeding can manifest the characteristics of hemorrhagic shock and may experience coagulopathy when resuscitated this is caused by the consumption of clotting factors and hemodilution due to crystalloid and colloid transfusion. [39] In addition to hemodynamics and urine output, hemoglobin, hematocrit, and coagulation profile (platelet count, prothrombin time, activated partial thromboplastin time, and plasma fibrinogen level) should be measured repeatedly and if onsite monitors are available, monitors should be used.[33] There is sufficient evidence to recommend the use of rotational thromboelastography and rotational thromboelastometry for the effective and rapid correction of coagulopathy in women in labor. Targeted therapy as targeted with specific coagulation factors based on the viscoelastic method was associated with less incidence of allogeneic blood transfusion and thromboembolic events.[3, 39]

Utilization of massive blood transfusion requires close monitoring in the ICU setting. This is certainly necessary to ensure the desired target patient condition is achieved and to avoid complications such as circulation overload, coagulopathy, electrolyte imbalance, hypothermia, TRALI, etc. [40] To ensure this, several parameters need to be considered, including Mean Arterial Pressure ≥ 60, SBP ≥ 80-100 mmHg, hemoglobin 7-9 gr%, INR <1.5, aPTT <42 second, fibrinogen > 1-1.5 gr%, platelet >50000/mm3, pH 7.35-7.45, temperature >35°C, lactate <2 mEq/L, and ionized calcium >1.1 mmol/L.

CONCLUSION

Careful clinical observation and a high index of suspicion are required for the early detection and management of obstetric hemorrhage.

Identification of patients at risk for peripartum blood loss using ultrasound or MRI may lead to early preparation of a multidisciplinary strategy, including massive transfusion protocols, embolization, arterial ballooning, and finally, hysterectomy. Massive transfusion protocols should be implemented to address the preoperative preparation of blood components and intraoperative management. Anesthetic management requires careful preoperative planning. Important management factors include optimization of hemoglobin, adequate intravenous access, availability of rapid infusion, monitoring of hemodynamic factors (including central and peripheral arterial and venous access), rapid availability of blood products, compression stockings, positioning to prevent nerve compression, and hypothermia treatment and prevention. Proper perioperative management of obstetric hemorrhage may reduce the morbidity and mortality of these patients.

CONFLICT OF INTERESTS

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