Chapter 45

OBSTETRIC ANESTHESIA

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INTRODUCTION

The management of obstetric cases by United Kingdom (UK) and US defense medical services has been a relatively rare event in recent operations. Practical experience from the deployed environment is therefore scarce. It is entirely plausible, however, that such cases may become a more significant feature of future US and UK operations, particularly those involving the management of refugee populations or relief following natural disasters (Figure 45-1). Consequently, medical personnel will need to maintain knowledge and skills in this area and include the potential for obstetric cases in operational medical planning.

The aims of this chapter are to:

- assess the likely challenges of obstetric care in the deployed environment,
- provide an overview of current civilian best practice, and
- point to some additional resources that may be helpful in preparing the military anesthesiologist for deployed obstetric practice.

CHALLENGES OF OBSTETRIC ANESTHESIA IN THE DEPLOYED ENVIRONMENT

In future operations, the number of obstetric cases presenting to UK and US military surgical facilities will depend on the tempo of operations (and consequent workload from trauma), as well as how the eligibility matrix for civilian personnel is conceived and applied. When humanitarian aims form a significant part of the overall concept of operations, there is likely to be a far greater emphasis on primary care, with a greater likelihood of obstetric referrals. In these situations, the potential obstetric workload is high, with caesarean section being the most likely nontrauma surgical intervention required in a conflict area.[1]

Figure 45-1. Operating theater door, Australia and New Zealand Army Corps Hospital, Banda Aceh, Indonesia, during Operation Sumatra Assist, 2004.
Photograph: Courtesy of the Australian Defence Force.

Preexisting Indigenous Standards of Care

The aim for all deployed medical teams should be to provide the highest possible standard of care. The provision of obstetric care in the absence of midwives or obstetricians will of necessity fall short of the clinical governance standards of the UK or United States. It is important, therefore, that the standard of care during deployment be considered in the context of the care otherwise available in the area of operations. Deployed providers should have an appreciation of the status of maternity care worldwide.

The World Health Organization (WHO) estimates that 1,000 women die daily from preventable causes related to pregnancy and childbirth. The leading causes are hemorrhage, infection, preeclampsia, obstructed labor, and unsafe abortion.[2] Where skilled intervention is not readily available, as in many developing countries, complications of childbirth become the leading cause of death for women of childbearing age.

United Nations (UN) Millennium Development Goal 5 aims to reduce maternal mortality by 75% between 1990 and 2015.[3] A number of national and international initiatives have been started to reach this goal, including "task-shifting": the training of traditional birth attendants and surgical technicians (capable of performing forceps and caesarean deliveries) to alleviate a lack of midwives and obstetricians.[4]

Despite such efforts, the statistics remain sobering. The published maternal mortality ratios (maternal deaths per 100,000 live births) for 2008 in the UK and United States were 8 and 17, respectively, compared with a world average of 251. In conflict zones, where healthcare infrastructure has broken down, this ratio can rise dramatically. In Sierra Leone the figure for 2008 was 1,033; in Afghanistan, 1,575.[5]

It is worth noting that a military force may have a far greater impact on maternal and neonatal mortality

with nonmedical interventions: by providing physical security, thereby minimizing sexual violence and allowing nongovernment organizations (NGOs) to operate freely; by ensuring safe water and sanitation; and by distributing shelter, food, and UN Population Fund and UN Children's Fund clean delivery kits.[6]

Obstetric Experience of Deployed Surgeons

Most deploying anesthesiologists have experienced obstetric anesthesia during their training. Deployed surgeons, however, may have little or no previous experience with obstetrics. Predeployment surgical training is likely to focus on core trauma surgery skills and may do little to advance the knowledge of obstetrics.

When humanitarian operations are planned or likely, individual or collective obstetrics training should be considered. The Australian Defence Force initiated simulation training in obstetrics for general surgeons following Operation Sumatra Assist in 2004, during which obstetric cases were numerous. If such training is not arranged at command level, individual hands-on training for surgeons by obstetric colleagues can prove to be time well spent. Guidance for surgeons can also be found in several field guides.[7–9]

Obstetric and surgical management is beyond the scope of this chapter, which is directed toward anesthesia and critical care. However, in the absence of obstetricians and midwives in the deployed environment, obstetric management will rely on shared anesthetic and surgical knowledge and skills. For these skills to be applied effectively, excellent communication and teamwork are mandatory.

Equipment Considerations

Military anesthesiologists may see pregnant patients in the context of obstetric emergency, trauma, or urgent nonobstetric surgery. The care of the parturient requires the ability to monitor fetal status and manage the unique physiologic changes that occur in pregnancy. These physiologic changes often complicate the treatment of other disease or injury. Pregnant patients may require equipment and drugs over and above what is routinely available in a field surgical unit. Some bulky or expensive items might be judged impractical to deploy where only an occasional obstetric case is expected. Such items might include neonatal resuscitation trolleys and cardiotocographs. Other important items, however, are readily transportable and should be considered as part of the equipment scaling whenever obstetric cases are possible or likely.

The World Federation of Societies of Anaesthesiologists established international guidelines for the practice of anesthesia in 1992, revising them in 2008.[10] These guidelines include recommendations for minimum equipment, medications, and supplies that should be available for the safe administration of anesthetics. The American Society of Anesthesiologists Task Force on Obstetric Anesthesia's 2007 practice guidelines for obstetric anesthesia provide both practice and equipment recommendations for the care of pregnant patients.[11] Table 45-1 provides a suggested equipment list that incorporates the recommendations of both organizations, while omitting those items that are routinely available in the deployed surgical facility.

Environmental Considerations

Normal Delivery

Sterility in the field environment can be difficult to maintain; fortunately, a sterile environment is not essential for a vaginal delivery. The UN clean delivery kits contain all the required supplies.[6]

Surgical Interventions and Nonobstetric Surgery

The same measures that are taken to provide a warm and sterile environment for a trauma case should be implemented to care for the pregnant surgical patient. In addition, steps must be taken to ensure that the operative environment is suitable for a neonate and that the operating room is prepared and equipped for the performance of a possible emergency caesarean section. A caesarean section may be a resuscitative surgery in its own right by serving to decompress the aorta and vena cava.[12] Surgical care of the parturient is therefore resource intensive, requiring additional nursing, anesthesia, and surgical assistance; advance planning is essential for its successful execution.

Preexisting Pathology in the Pregnant Patient

Obstetric Risk Factors

Where medical infrastructure is poor, unidentified maternal risk factors are of great concern when caring for the pregnant patient. Risk factors that should be identified in the obstetric history include quality of prenatal care, multiparity, previous caesarean sections and the techniques used, genital mutilation (see below), frequent or untreated venereal disease, and multiple sexual partners. These risk factors impact on the likelihood of maternal complications such as placenta previa, placenta accreta, ectopic pregnancy, uterine rupture, uterine atony, cervical adhesions, and preeclampsia.

TABLE 45-1

EQUIPMENT RECOMMENDATIONS FOR OBSTETRIC CARE

Durable Equipment	Drugs	Consumable Equipment
Maternal Care	***Spinal/ Epidural***	***Maternal Care***
Uterine displacement device (Cardiff wedge)	Bupivacaine "heavy,"0.5%	Spinal needles (25-g Whitacre or Sprotte [B Braun; Melsungen, Germany])
Fetal heart rate monitoring device (fetal stethoscope, ultrasonic stethoscope, Doppler ultrasound device or ultrasound imaging system with low frequency [<5 MHz] probe)	Lidocaine, 2%	Epidural kits
	Bupivacaine "plain,"0.5% (or levobupivacaine/ropivacaine as preferred)	***Neonatal Care***
Neonatal Care	***Uterotonic***	Face masks (sizes 00, 0, 1)
Pediatric anesthesia circuits (Ayres T-piece)	Oxytocin	LMAs (size 3-4)
Neonatal bag valve masks with PEEP valve (240–500 mL)	Ergometrine/methylergonovine	ETTs (size 2–4.5)
Pediatric skin temperature probes	Carboprost tromethamine	IV cannulae (22–24 g)
Laryngoscopes (Miller, Oxford, and Wisconsin, sizes 0–1)	Misoprostol	Low-pressure suction, tubing and catheters (size 8 Fr)
ETT stylets (size 6 Fr)	***Tocolytic***	Bulb suction
	Nifedipine	
	Nitroglycerine (tab and solution)	
	Antihypertensive	
	Labetalol	
	Hydralazine	
	Magnesium	
	Inotropic/Vasopressor	
	Ephedrine	
	Phenylephrine	
	Epinephrine	
	Antacid/Prokinetic	
	Ranitidine	
	Sodium citrate	
	Metoclopramide	
	Resuscitative	
	Intralipid (KabiVitrum Inc, Alameda, CA)	

ETT: endotracheal tube
IV: intravascular
LMA: laryngeal mask airway
PEEP: positive end-expiratory pressure
Data sources: (1) World Federation of Societies of Anaesthesiologists. The 2008 international standards for a safe practice of anaesthesia. *Anesteziol Reanimatol*. 2009;(6):4–10. (2) Hawkins JL, Arens JF, Bucklin BA, et al. Practice guidelines for obstetric anesthesia. American Society of Anesthesiologists Task Force on Obstetric Anesthesia. *Anesthesiology*. 2007;106(4):843–863..

Cardiac Disease

In the developing world, cardiac disease is high on the list of causes of maternal mortality. The most common presenting pathology is mitral stenosis secondary to rheumatic fever. Other conditions include other valve lesions, cardiomyopathy (sometimes relating to human immunodeficiency virus [HIV]), and ischemic heart disease.

Patients tend to present late with decompensation secondary to the increased cardiovascular demands of late pregnancy or labor. The pathology may be unknown, and unless sufficient transthoracic echocardiography skills are available within the deployed medical team, diagnosis will depend upon a comprehensive cardiovascular examination.

Key management principles include the following:

- Good analgesia should be maintained during labor to minimize sympathetic drive and myocardial oxygen demand.
- Caution should be exercised with fluids to avoid overload.
- Oxytocin should be given slowly and with caution because it may precipitate hypoten-

sion and tachyarrhythmias.
- In the patient showing signs of cardiac failure, invasive cardiovascular monitoring may assist in maintaining optimal fluid balance, cardiac output (with or without inotropic support), and hence placental perfusion. Patients should be monitored for 48 hours postdelivery because decompensation may occur postpartum.
- Both regional and general anesthesia are safe if performed carefully, although general and epidural techniques are generally safer than spinal anesthesia in patients with fixed cardiac output (cardiomyopathy or aortic stenosis). An elective caesarean section under "slow-loading" epidural is perhaps the most stable combination in the high-risk parturient.

Human Immunodeficiency Virus Infection

HIV infection is common in the developing world. In the absence of advanced end-organ sequelae, HIV represents a low risk to the parturient but a significant risk to the medical team (including from concurrent hepatitis B or C infection) and a high risk of vertical infection to the neonate. When a high viral load is known or suspected, planned caesarean section at 38 to 39 weeks is the safest mode of delivery.

Ideally, antiretroviral therapy should be given from the second trimester. If this has not been possible, postexposure prophylaxis should be given to the neonate (nevirapine and zidovudine) for 6 weeks with formula-feeding to reduce transmission risk. However, if formula-feeding cannot be done hygienically in the home setting, breast-feeding will be safer, with antiretrovirals continued until weaning is complete.

Malaria

Malaria is endemic in many parts of the developing world and presents with anemia and low birth weight. Infection rates are higher in primigravidae, and reduce with subsequent pregnancies (this protective effect is reduced with concurrent HIV infection). WHO control strategies include impregnated mosquito netting and intermittent preventive treatment with sulfadoxine-pyrimethamine during pregnancy. Advice on current recommendations for antimicrobial therapy in the pregnant patient should be sought from a microbiologist or infectious diseases specialist. Concurrent anemia may also require treatment (see below).

Anemia

Severe anemia (hemoglobin < 7 g/dL) is associated with increased maternal and perinatal mortality, as well as developmental problems in children. Causes include helminth infestation; HIV; malaria; sickle-cell disease; hemoglobinopathies; and dietary iron, B12, and folate deficiencies. Helminth infestation (most commonly hookworm) can be diagnosed by the presence of eggs in the feces. Where suspected (ie, in endemic areas), helminth infestation can be treated after the first trimester with a single dose of mebendazole 500 mg or albendazole 400 mg.

In acute presentation of anemia, particularly with concurrent hemorrhage, transfusion may be necessary to bring hemoglobin to appropriate levels. In the longer term, a rise of 0.2 g/dL/week can be achieved with ferrous sulfate 200 mg three times a day and folic acid 5 mg once a day.

Sexual Violence

Sexual violence has sadly been a feature of a number of recent conflicts, including those in Africa and the Balkans, with vulnerable subjugated populations and refugees subjected to systematic as well as opportunistic rape. As a consequence, medical staff should be alert to the potential psychological damage parturients may present with. These effects may manifest as increased fear of clinical examination or ambivalence toward the newborn child. Particular sensitivity should be exercised as well as maximum use of interpreters to facilitate good communication. Chaperones including female staff, friends, or relatives should be employed as appropriate.

Female genital mutilation, though internationally condemned, remains a widespread practice in about 28 countries in sub-Saharan Africa and Yemen, with an estimated 92 million women and girls affected.[13] The level of damage is variable, including a 15% to 55% increase in perinatal mortality, as well as urinary tract infections and cyst and abscess formation. Severe, constrictive scarring (following type III female genital mutilation, or infibulation) carries a high risk of failure to deliver vaginally, resulting in a 30% increase in caesarean sections and a 70% increase in postpartum hemorrhage.[14]

CURRENT CIVILIAN BEST PRACTICE

Patient Information

In all contact with pregnant women, efforts should be made to ensure that they have access to information, including an explanation of pain relief options as well as the risks and benefits of any surgical or

anesthetic interventions. All information should be given in appropriate language, either written or via interpreter. In patriarchal cultures, care should be exercised if male relatives are used as interpreters to ensure that the woman retains freedom of choice about her care.

Antenatal Care

A well-managed obstetric anesthesia service can help reduce maternal mortality. The deployed medical team may have limited access to parturients in the antenatal period. However, it may be possible to establish cooperative liaisons with local antenatal or primary care services, whether indigenous or provided by NGOs. Guidelines should be made available to local primary care clinicians on conditions requiring referral.

Management of Normal Labor

Aortocaval Compression

Pregnant women should never lie completely supine because the gravid uterus will cause aortocaval compression, leading to compromised placental perfusion. A tilting table, wedge, or pillows should always be used to create 15 degrees of left lateral tilt.

Pain Relief During Labor

Pain in the first stage of labor is caused by uterine contractions and progressive dilatation of the cervix, and so falls within a T8–L1 nerve root distribution. During the second stage, pain is also caused by stretching of the birth canal and perineum (T8–S4 nerve roots).

Parental Opioids. All parental opioids may cause respiratory depression, so both mother and baby need to be monitored closely in the intrapartum and postpartum period.

- ***Pethidine***. This drug is widely used by midwives in the UK as a first-line drug for labor analgesia. It may sometimes be available in the deployed environment. It is usually administered intramuscularly (IM), 75 mg every 4 hours. Its onset is within 10 minutes and it lasts 2 to 3 hours. It readily crosses the placenta and becomes ionized in the relative acidic fetal circulation leading to accumulation. Peak fetal concentrations occur 2 to 3 hours after administration. It should be used with caution in patients with epilepsy, renal failure, or preeclampsia.
- ***Morphine***. Morphine 5 to 10 mg may be administered IM or intravascularly (IV) as an incremental bolus dose or via a patient-controlled analgesia pump. Its peak analgesic effect is 30 to 60 minutes after IM administration, and it lasts for 3 to 4 hours. It rapidly crosses the placenta but diffuses back into the maternal circulation.
- ***Fentanyl***. IV boluses of 25 to 100 μg can be effective up to 30 to 60 minutes. It is highly lipid soluble and readily crosses the placenta.
- ***Remifentanil***. Because of its short elimination half-life (9.5 min) and context-sensitive half-time (3 min), remifentanil provides high quality analgesia without neonatal depression. It is therefore becoming widely used in UK and US obstetric practice, and is likely to be available in the deployed setting. It is best used in the form of a patient-controlled analgesia regimen. It should be administered by experienced practitioners only, using an established protocol such as a 40-μg bolus with a 2-minute lockout.
- ***Inhalational Methods: Entonox.*** A 50:50 mix of oxygen and nitrous oxide with dissociation and relaxation properties, Entonox (BOC, Guildford, UK) decreases the mother's perception of labor pain. The drug diffuses freely across alveolar membranes to provide rapid effects with minimal accumulation, but 15% of mothers experience nausea. Under anesthetic supervision, isoflurane 0.2% or sevoflurane 0.4% can be added to provide additional anxiolysis and sedation.

Regional Techniques. Indications for regional analgesia in labor (both epidural and combined spinal-epidural techniques) include maternal request, preeclampsia, augmentation or induction of labor, maternal cardiac or respiratory disease, predicted difficult airway or general anesthesia, or occipito-posterior presentation. Regional analgesia should not be used in labor unless an obstetric team is available in the same hospital to treat emergencies. There should be a regional analgesia record and a protocol for prescription and administration of epidural drugs. The provider must adequately inform the patient and obtain her consent. The patient must have wide-bore IV access before a regional technique is performed, and Intralipid (KabiVitrum Inc, Alameda, CA) should be available as a resuscitative drug to treat local anesthetic toxicity.

- ***Epidural***. Once an epidural is inserted for labor, an appropriate block should be estab-

lished. The possibility of intrathecal and IV placement cannot be ruled out until the epidural is tested. Following a test dose (typically 3–4 mL of bupivacaine 0.25%), bolus doses of local anesthetic solutions (eg, bupivacaine 0.1%–0.25% or equivalent ropivacaine) are injected to give sufficient analgesia. In the first stage of labor, the block must extend from T8 to L1; in the second stage, from T8 to S4. Maintenance of analgesia can be achieved with further bolus doses or continuous infusion (a typical infusion in the United Kingdom contain 0.1% bupivacaine with 2 μg/mL fentanyl. In the United States, 0.2% ropivacaine is typical). Epidurals that provide good quality analgesia for labor can also be used for caesarean section, forceps delivery, perineal suturing, and manual removal of placenta.

- ***Combined Spinal-Epidural.*** A combined spinal-epidural can be used to achieve rapid onset of analgesia in labor. Either a needle-through-needle technique or separate insertion sites can be used. The spinal component must use a lower dose than for operative interventions (see below), typically consisting of 1 mL of 0.25% bupivacaine with 25 μg fentanyl.

Management of Operative Interventions

Regional Anesthesia

Regional anesthesia is the method of choice for all operative interventions. A block to T4 is required for caesarean section (or for trial of forceps to enable a swift conversion to caesarean section if required). If an epidural is in place for labor analgesia and is working well, it can be "topped-up," typically using either

- 0.5% bupivacaine (in 5 mL increments up to 30 mL)

or

- fentanyl 100 μg plus 5 mL increments of a mixture containing 2% lidocaine (17 mL), epinephrine (1 mL of 1:10,000) and bicarbonate (2 mL of 8.4%) titrated to the block level.

In the absence of an existing epidural, spinal anesthesia offers a more rapid onset of block with a lower incidence of inadequate block requiring conversion to general anesthesia. This is usually achieved with a 24- or 25-gauge Whitacre or Sprotte (B Braun; Melsungen, Germany) needle at the L2-3 or L3-4 interspace. The block is typically established with 2.5 to 2.6 mL of 0.5% "heavy" bupivacaine, with the addition of 300 to 400 μg diamorphine or 15 μg fentanyl.

General Anesthesia

General anesthesia is necessary when regional anesthesia is contraindicated, refused, unavailable, or unsuccessful. Rapid sequence induction is mandatory, and the anesthesiologist should expect and prepare for difficult intubation. Pregnant women are at particular risk of aspiration because of reduced effectiveness of the lower esophageal sphincter, increased intragastric pressure caused by a large uterus, and delayed gastric emptying if opiates are used during labor. The increased risk of aspiration starts from 16 to 18 weeks' gestation and continues into the first week postpartum. The risk is reduced by avoiding general anesthesia (using regional anesthesia when possible) and by decreasing gastric volume and acidity with the administration of H_2 antagonists (ranitidine 150 mg, orally, every 6 h or 50 mg slow IV together with metoclopramide 10 mg orally or IV when general anesthesia becomes likely. Rapid sequence intubation with cricoid pressure should be performed if control of the airway is required, with nonparticulate antacids (sodium citrate 30 mL orally) given prior to preoxygenation.

Fetal Monitoring

The American Congress of Obstetricians and Gynecologists Committee Opinion 474 holds that if the fetus is considered viable, fetal heart rate and contraction monitoring should be done pre- and postoperatively[15] for surgery in pregnant patients. However, it is unlikely that the equipment necessary for contraction monitoring will be available in the field environment, nor is it likely that individuals trained in the interpretation of such monitors will be at hand. The American Society of Anesthesiologists Practice Guidelines recognizes that "continuous electronic recording of the fetal heart rate may not be necessary in every clinical setting."[11] This guideline agrees with the observation that neonatal outcome is most affected by the course of the maternal illness, rather than any specific monitoring modality, unless the fetal monitoring affects maternal outcome.[16] It would seem appropriate to monitor fetal heart rate at regular intervals (with frequency determined by the clinical course) when managing any parturient to assess fetal well-being and the possible need for emergent delivery. Additional fetal monitoring is likely of no benefit. In the case of nonobstetric surgery, pre- and postoperative monitoring should be sufficient.

Tocolysis

Uterine relaxation may be required to facilitate removal of retained placenta or to aid in the delivery of infants with head entrapment during a caesarean section. Short-duration uterine relaxation can be accomplished with nifedipine, volatile anesthetics, or nitroglycerine.

Procedures

- **Assisted delivery**. Takes place on the ward with an obstetrician in attendance. The patient often requires a good working epidural.
- **Trial of forceps**. Takes place in the operating room because of the significant likelihood of conversion to caesarean section. Regional analgesia needs to be in place with a block up to the level of T4. Oxytocin 5 units IV should be given after cord clamping.
- **Caesarean section**. Should be under regional anesthesia unless contraindicated or there is insufficient time to establish a block due to severe maternal or fetal compromise. A T4 block is required. Oxytocin 5 units IV should be given after cord clamping.
- **Manual removal of placenta**. Performed in the operating room. Close observation of maternal blood loss is required. Tocolysis may be required.
- **Perineal repair**. Can be performed on the ward using a local anesthetic block by the obstetrician. More extensive tears (grade 3–4) are repaired in the operating room.

Management of High-Risk Conditions

Preeclampsia and Eclampsia

Preeclampsia complicates up to 8% of pregnancies and is characterized by hypertension, proteinuria, and edema. If uncontrolled it can lead to death from intracranial hemorrhage, pulmonary edema, or hepatorenal failure with coagulopathy (HELLP syndrome: hemolysis, elevated liver enzymes, and low platelets). Hypertension should be controlled with labetalol or hydralazine. Headache, epigastric pain, and hyperreflexia are markers of severe disease and impending eclamptic seizure and should prompt the use of a magnesium infusion and a plan for early delivery.

In eclamptic seizures, immediate infusion of magnesium (4 g IV over 20 min followed by 1 g/h IV infusion) should be added to supportive treatment. Caesarean section should not be performed until blood pressure has been controlled, due to the high risk of cerebral and operative hemorrhage.

Regional anesthesia is safe and effective provided that platelet numbers are adequate. If general anesthesia is required, a generous induction agent and opioids should be used to reduce the sympathetic response to laryngoscopy, which may provoke intracranial hemorrhage (opioid narcosis in the neonate should be expected and managed with naloxone if required).

Throughout management, fluids should be restricted (typically replacing losses plus 85 mL/h) to avoid pulmonary edema. Fluid boluses may be given to counteract hypotension caused by regional anesthesia (although parturients with preeclampsia are relatively protected from this effect), but oliguria in the first 24 to 48 hours postpartum should not prompt excessive fluid administration. The risk of eclamptic seizures and HELLP syndrome persists for several days postdelivery, so close observation and serial electrolytes, blood counts, and liver function tests are mandatory.

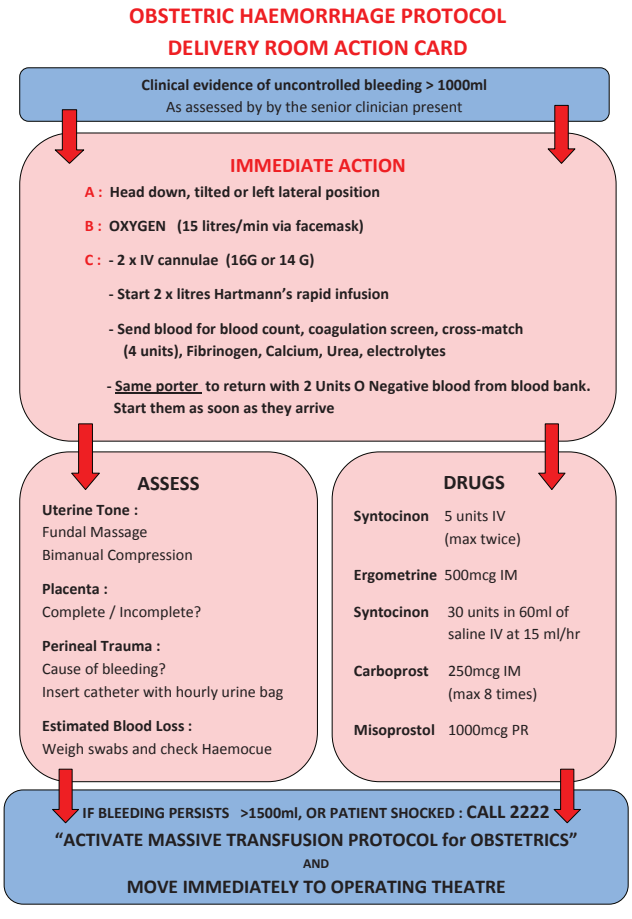

Figure 45-2. Obstetric Haemorrhage Protocol Delivery Room Action Card, printed by Siggers B, Baden-Fuller J, January 2011 (reproduced with permission).

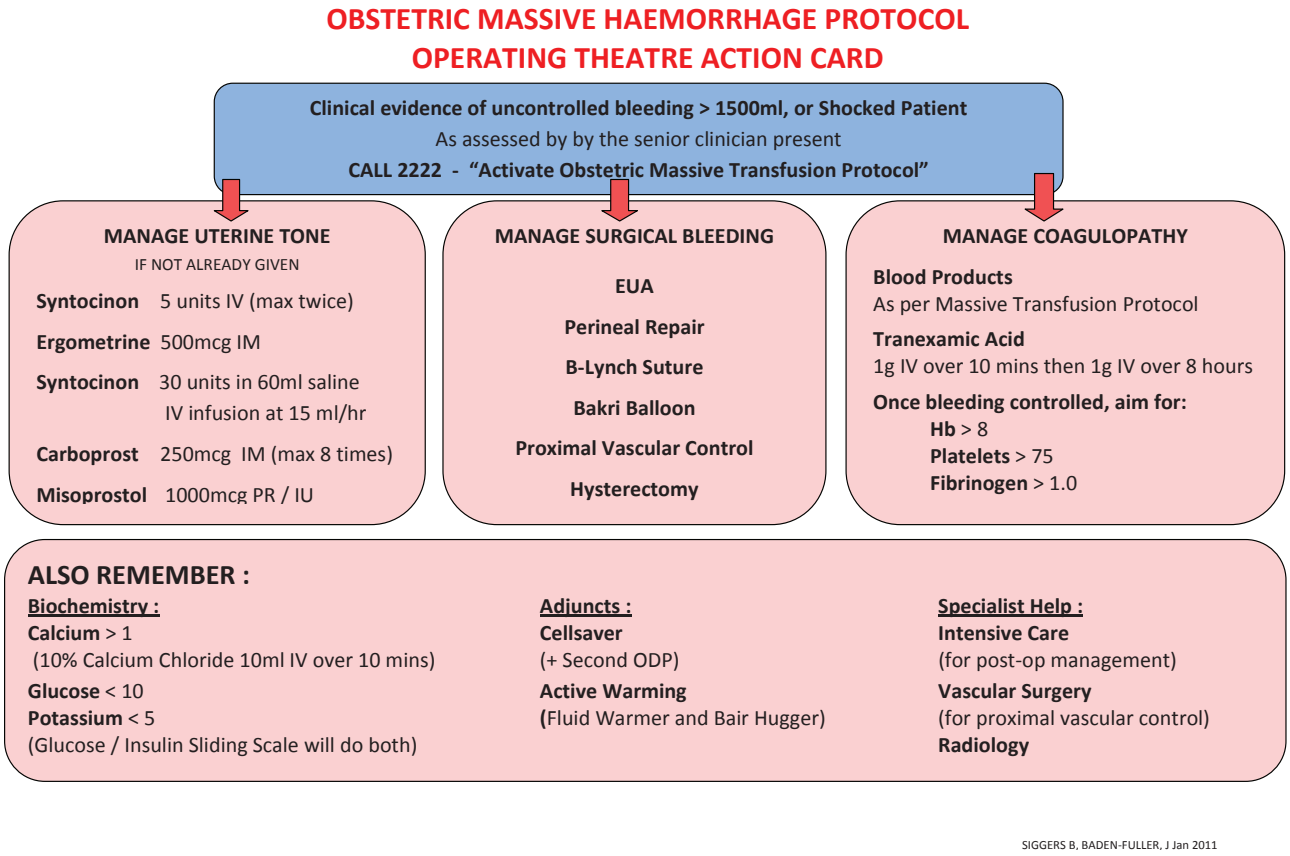

Figure 45-3. Obstetric Massive Haemorrhage Protocol Operating Room Action Card, printed by Siggers B, Baden-Fuller J, January 2011 (reproduced with permission).

Massive Hemorrhage

Antepartum hemorrhage may occur in association with placental abruption or uterine rupture. Postpartum hemorrhage is most commonly associated with uterine atony (risk factors include placenta previa, multiparity, twins, and prolonged labor) as well as placenta accreta or cervical, vaginal, or perineal tears.

Both the hemorrhage and associated coagulopathy may be rapid and catastrophic and should be managed aggressively in line with the massive transfusion protocol in place for traumatic hemorrhage. In addition, measures to stop the bleeding should include mechanical uterine compression, surgical hemostatic maneuvers, and pharmacological means to restore uterine tone. Uterine muscle requires good perfusion to contract effectively. Figures 45-2 and 45-3 provide algorithmic guides to initial and operative management of obstetric hemorrhage. Initial transfusion should occur with type O, Rh-negative blood until type-specific or cross-matched blood is available, to prevent isoimmunization.[12]

Amniotic Fluid Embolism

Contamination of the maternal circulation with amniotic fluid containing fetal skin squamae at the time of delivery may produce a systemic inflammatory response as well as an embolic effect if the bolus of amniotic fluid is large. The effects range from mild to complete cardiovascular collapse and cardiac arrest. Management is wholly supportive.

Trauma

Since most military medical facilities are deployed with the primary objective of managing trauma, many of the pregnant patients who present do so because of traumatic injury. An understanding of the interaction between pregnancy and trauma is fundamental to effective management of the pregnant trauma patient.[16,17]

Pattern of Injury. Trauma to the abdomen or pelvis may cause placental abruption or uterine rupture, resulting in fetal compromise or maternal blood

loss, amniotic fluid embolism, or coagulopathy. The fetus may also be injured directly. The uterus remains within the pelvis up to 12 weeks gestation. From 12 to 20 weeks, the fundus rises from the pelvic rim to the level of the umbilicus, and by 36 weeks the uterine fundus reaches the anterior costal margin. In the first trimester the uterus is thick-walled as well as being protected within the pelvis. In the second trimester, the fetus is relatively cushioned from blunt and penetrating trauma by the uterine wall and surrounding amniotic fluid. However, by the third trimester, the uterine wall is thinner and the fetus larger, so the uterus and fetus are vulnerable to direct trauma, while other organs are relatively protected behind or above the uterus.[18]

Hemodynamics. Physiological changes in pregnancy have evolved to provide for both increased cardiac output during labor and increased ability to survive blood loss during delivery. The important consequence for major trauma in late pregnancy is the increased capacity to compensate for bleeding, which may provide false reassurance by masking signs of blood loss. If a source of bleeding is missed as a consequence, the eventual decompensation can be sudden and catastrophic. A high index of suspicion is mandatory.

Aortocaval compression in the supine position may severely compromise maternal cardiac output. Compromised placental perfusion may be one of the first consequences of maternal hypovolemia, so fetal distress may occur before signs of shock in the mother.

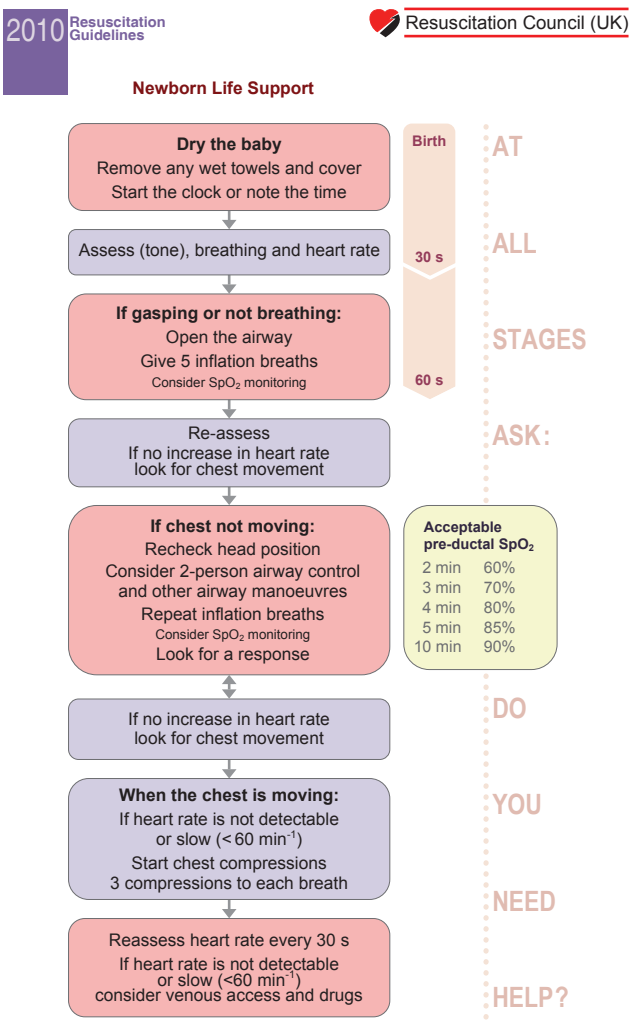

Figure 45-4. Resuscitation Council (UK) 2010 Resuscitation Guidelines, Newborn Life Support algorithm card. Reproduced with the kind permission of the Resuscitation Council (UK).

Trauma Management Principles

- Maintaining maternal physiology is the best way to protect the fetus.
- Manage with left tilt to prevent aortocaval compression.
- Maintain maternal cardiac output aggressively to maintain placental perfusion.
- Actively look for signs of abruption as part of the primary survey. These signs include perivaginal bleeding and uterine tenderness or irritability (frequent contractions or tetany, contractions triggered by palpation)
- Actively look for signs of uterine rupture as part of the primary survey. These signs include easily palpable fetal parts, cramping pain, and tenderness and guarding, especially when associated with maternal shock or fetal distress.
- Focused abdominal ultrasound scan for trauma (FAST scan) may assist in diagnosing both of these conditions, but the presence of the pregnant uterus may make it more difficult to see free fluid elsewhere in the abdomen.
- Indications for caesarean delivery include uterine rupture (including penetrating injury to the uterus), significant placental abruption, or fetal compromise.
- Monitor fetal wellbeing for 48 hours after maternal stabilization.
- Rh-negative mothers with torso trauma should receive rhesus immunoglobulin therapy within 72 hours of injury due to the high risk of fetomaternal hemorrhage.

Postnatal Care

Observation

Basic observations are required for all women postdelivery, including heart rate, blood pressure, respiratory rate, pulse oximetry, sedation scores, and pain scores. Effective postdelivery monitoring reduces the incidence of maternal morbidity and mortality. All women who receive anesthesia or regional analgesia should receive an anesthetic review between 18 and 36 hours postdelivery. The review should include inquiries into effectiveness of analgesia or the anesthetic intervention, maternal satisfaction, and any anesthetic-related morbidity.

Fluid Management

Careful fluid management is required to prevent postoperative renal failure or postoperative fluid overload and pulmonary edema. This is particularly important in the presence of preeclampsia (see above). Preoperative deficit, blood loss during delivery, and daily maintenance should be taken into consideration.

Pain Control

A multimodal approach is required, with a combination of paracetamol (acetaminophen), nonsteroidal antiinflamatory drugs (NSAIDs), and opioids. NSAIDs should not be given in cases of large blood loss or preemclampsia.

Neonatal Care

Most newborn babies require only minimal intervention following birth; however, some will need extra support. Many cases of death and disability can be prevented by early recognition of at-risk pregnancies, timely intervention for complicated labor, and immediate resuscitation of at-risk babies. Following birth, the newborn should be dried and covered to conserve heat. An assessment should be made as to whether further intervention is required. For the compromised newborn, resuscitation is a priority. Figure 45-4 shows the Resuscitation Council (UK) Newborn Life Support algorithm (2010), an internationally recognized best practice standard.

RESOURCES FOR THE DEPLOYING ANESTHESIOLOGIST

Civilian Best Practice

Training with obstetric anesthesia colleagues remains the most effective means of revising and updating skills in preparation for deployment. A variety of organizations also offer courses and seminars aimed at updating civilian obstetric anesthesia practice. These include, in the UK, the Obstetric Anaesthetists Association, and in the United States, the Society for Obstetric Anesthesia and Perinatology. Current literature, in particular the *International Journal of Obstetric Anesthesia*, contains relevant articles from the developing world, as well as US and UK best practice. Textbooks of particular relevance to this subject include *Obstetric Anaesthesia for Developing Countries* by Clyburn, Collis, and Harries.[19]

Military Experience

The Australian Defence Force medical services have encountered numerous obstetric cases in recent years following a series of operations with a humanitarian component. These include operations in East Timor (1999), tsunamis in Papua New Guinea (1998) and Indonesia (2004; see Figure 45-1), and the 2005 Pakistan earthquake. Reports of these deployments provide helpful insights into the role and challenges facing military medical teams in such circumstances.[20]

Specific advice on the management of ballistic trauma in the pregnant patient can be found in the relevant chapter of *Ryan's Ballistic Trauma* (3rd edition).[21]

Deployed Civilian Experience

The burden of obstetric care in conflict and disaster areas in recent years has largely fallen on NGOs. Guiding principles for maternity services were agreed on by the Reproductive Health Response in Conflict Consortium and published as a field-friendly guide in 2005.[6] The WHO also includes practical guidance for obstetric surgical care in the 2003 manual *Surgical Care at the District Hospital*.[7] This excellent resource includes downloadable teaching slides, videos, and self-directed learning aids that can assist in team training prior to or during deployment. The WHO also provides a range of topic-specific clinical guides, available with open access at www.who.int/reproductivehealth/publications/maternal_perinatal_health. A recent editorial by Dyer et al[22] discusses equipment and principles and includes example protocols for anesthetic management.

SUMMARY

This chapter provides a guide for deploying anesthesiologists and surgical teams who may encounter pregnant patients. It offers some context in the form of a summary of obstetric care worldwide and lists likely challenges. It suggests options and resources for equipment and individual and team preparation. Finally, the chapter provides a detailed breakdown of civilian best practice and how it can be best applied to the deployed military setting.

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