Review

Management of trauma and injuries during pregnancy: challenges for an obstetrician and the intensivist

Sukhwinder Kaur Bajwa[1], **Ravi Jindal**[2], **Sukhminder Jit Singh Bajwa**[1], **Ratika Jindal**[2]

Sri Lanka Journal of Obstetrics and Gynaecology 2012; **34**: 58-64

Introduction

The incidence of road side accidents and trauma has increased several folds in developing nations and so is the number of therapeutic interventions and advancement in management of such victims[1]. However, on numerous occasions such episodes can lead to life threatening condition thus raising the mortality and morbidity associated with such accidents. These risks are accentuated in pregnant women as two lives are at stake. The care of critically ill pregnant patient is a huge challenging task for the attending intensivist[1,2]. A review by Connolly and co-workers found that amongst the pregnant trauma patients 54.6% of the incidents were motor vehicle accidents: 22.3% were domestic abuse and assaults, 21.8% were associated with falls, and 1.3% were secondary to burns, puncture wounds, or animal bites[3]. The present socio-economic conditions, inability to support families on a single income, and desire to pursue careers have increased the risk of trauma amongst pregnant women[4]. While managing a reproductive age female trauma victim one should always suspect pregnancy.

Normal physiologic alterations during gestation

Managing a pregnant trauma patient requires proper understanding of the physiological alterations taking place during various stages of antenatal period. Due to these anatomical and physiological changes, the pathophysiology and location of maternal injuries during the antenatal period may vary significantly from the non-pregnant state. Further, the management also varies due to these changes[5].

As the uterus increases in size, it becomes more vulnerable to blunt as well as penetrating trauma. The uterus remains an intrapelvic organ until the 12th week of gestation. Later it begins to rise out of the pelvis and encroaches the peritoneal cavity. By 24 weeks, the uterus will be at the level of the umbilicus. At 36 weeks it reaches its maximal supraumbilical extent. Enlarging uterus reduces the intraperitoneal space, restricting the intestines to the upper abdomen. The fetus is initially well protected by the thick walled uterus and large amounts of amniotic fluid. The amniotic fluid itself could be a source of embolism and disseminated intravascular coagulation following trauma[4].

There is sinus tachycardia with the heart rate gradually increasing by 15-20 beats/minute. Reduced systemic vascular resistance lowers the blood pressure by approximately 15 mmHg. Cardiac output increases by approximately 1.5 litres per minute. Supine hypotension syndrome may occur during the third trimester due to vena cava compression in the supine position. There is increase in tidal volume, and respiratory rate resulting in respiratory alkalosis[5].

The placenta reaches its maximum size by 36 to 38 weeks of gestation and is devoid of elastic tissue. This predisposes the patient to shearing stress leading to increased risk of abruptio placentae. Direct trauma to the uterus and placenta releases high concentration of placental thromboplastin or plasminogen activator from the myometrium[6,7].

Trauma may be associated with significant loss of circulating blood volume due to haemorrhage. A pregnant woman is usually young and healthy. Thus she can adapt to the challenge more easily.

The blood volume increases during pregnancy by 35-40%. Hence, the actual amount of blood loss that results in clinical signs of response is greater in pregnant women than in nonpregnant women.

Fetal tolerance of maternal haemorrhage depends on the degree of maternal sympathetic response, the oxygen carrying capacity of the maternal blood, and maternal blood pressure. An acute decrease in intravascular blood volume causes early fetal acidosis as the fetus relies entirely on maternal cardiovascular function and placental transfer of oxygen[5,8].

[1] *Department of Obstetrics and Gynaecology,*
[2] *Department of Anaesthesiology and Intensive Care, Gian Sagar Medical College and Hospital, India.*
Correspondence: Sukhwinder Kaur Bajwa
E-mail: sukhwinderbajwa2001@gmail.com

Pregnancy induced generalized weight gain, increase in breast size, respiratory tract mucosal oedema, decreased functional residual capacity (FRC), and increased oxygen consumption during pregnancy result in difficult intubation and increased chances of airway management complications. Hence a short handled laryngoscope may be required. Also a smaller internal diameter endotracheal tube may be required due to laryngeal oedema[9,10].

Impact of maternal pathophysiology on fetus

Hypoxia, placental abnormalities, infection, drug effects, and preterm delivery are the most important causes of fetal morbidity and mortality. Fetal death usually results from fetal hypoxia. Fetal hypoxia, and acidosis result due to a decrease in maternal hematocrit greater than 50% and a decrease in maternal mean blood pressure of 20% or a maternal PaO_2 less than 60 mmHg (oxygen saturation <90%).

The most important surgical risk to the fetus is preterm delivery. Before 23 weeks' gestation, preterm delivery uniformly results in neonatal mortality. Major long-term defects associated with delivery at 24, 25, 26, and 28 weeks occur in 70%, 50%, 40%, and 20% of neonates, respectively. After 28 weeks' gestation, chances of survival are greater. Preterm labour in a trauma patient usually results from abruptio placentae. However, other etiologies must be kept in mind. Preterm labour may be the cause of abdominal pain or a consequence of nonobstetric disease, trauma, or infection.

Management of preterm labour in trauma or after trauma surgery involves:

1. Uterine irritability is not considered labour until evidence of cervical effacement or dilatation exists.
2. Prophylactic tocolysis is not indicated. Tocolysis is started only when the following are present: cervical changes of labour, assurance that membranes are intact, and the absence of the contraindications for tocolytics. Also the presence or absence of intrauterine disease is determined by a thorough physical and ultrasonography examination and, perhaps, amniocentesis[11].

Further, anaesthesia for surgical interventions common in maternal trauma may itself be an independent risk factor for the fetus. There are conflicting reports on increased risk of first trimester abortion as well as fetal malformations due to anaesthesia. After 13 weeks the risk of congenital malformations is minimal. After 24 weeks, surgical intervention for trauma may lead to supine hypotension, neurodevelopmental delay in the offspring, and preterm birth[11-13].

An uninterrupted supply of oxygenated blood to the fetus is important. Therefore, hypotension should be treated aggressively. To avoid aorto-caval compression, a pregnant patient should be transported and evaluated on her left side (unless a spinal injury is suspected)[6,14].

Despite successful resuscitative measures, if fetal distress is present, an emergency caesarean delivery must be performed. However, a non viable fetus may be managed conservatively in utero to optimize maternal oxygenation and circulation[4].

At any gestational age, documentation of a live fetus by fetal heart auscultation should be done. Continuous fetal monitoring for fetal heart rate changes may be required. During recovery, once patient's condition stabilizes and consciousness is regained, continuous fetal assessment may be discontinued. Further fetal assessment may be done using a combination of recording 10 fetal movements every 12 hours and a nonstress test twice a week till the patient returns to the usual functional state.

Similarly during the acute phase, continuous uterine contraction monitoring may be used after 20-22 weeks' gestation with a normally formed fetus. Serial cervical examinations are essential for the diagnosis of preterm labour. If no uterine irritability exists, the patient's condition has stabilized, and she can recognize and report fetal movement and contractions, then continuous uterine contraction monitoring can be replaced by maternal perception and patient education about the signs of preterm labour[11].

Mechanisms of injuries and trauma during pregnancy

Severity of injuries determines maternal and fetal outcome. The management, therefore, is also dependent on the severity of maternal injuries. All pregnant women suffering from major injuries should be hospitalised in a setup where surgical as well as obstetric facilities are available. Those with minor injuries should be carefully observed because of risk of complications like fetomaternal haemorrhage. Direct fetal injuries usually tend to occur in late pregnancy, and are typically associated with serious maternal trauma.

Blunt injury abdomen

Blunt trauma during pregnancy may occur due to motor vehicle accidents (40%), fall (30%) and interpersonal violence (20%). During pregnancy, enlarging uterus looses the protection of the bony

pelvis. However, the amniotic fluid, by absorbing the thrust of blunt trauma, protects the fetus to some extent. Engorgement of the pelvic vessels leads to an increase in the chances of retroperitoneal haemorrhage as a result of blunt abdominal trauma[15-17].

Fetal mortality after maternal blunt trauma occurs mostly due to placental abruption, maternal shock, and maternal death[18,19].

Penetrating trauma

Penetrating trauma during pregnancy occurs due to gunshot and stab wounds. Fetal and maternal morbidity and mortality are significantly different. As the pregnancy progresses there is a change in the position of intraabdominal organs – the bowel is pushed up and enlarging uterus occupies most of the abdomen. Hence, penetrating injury to the upper part of the abdomen usually leads to multiple gastrointestinal injuries. During the third trimester, injuries to the lower quadrants of the abdomen almost exclusively involve the uterus. Because the uterus and the amniotic fluid absorb most of the energy of the penetrating object, organ destruction is less[20].

Impact of cranial trauma during pregnancy

Head and neck injuries, respiratory failure, and hypovolemic shock are the most frequent causes of trauma related maternal death in pregnancy[3]. The management of such patients has a number of constraints – (a) an elevated intracranial pressure (ICP), (b) presence of cervical spine injury, (c) a difficult airway, (d) hypovolemia, (e) altered consciousness, (f) full stomach patient, (g) reduced oxygenation, and (h) pregnancy[10].

Mannual "inline stabilization" of the head and neck by an assistant to prevent extension and rotation of the cervical spine during direct laryngoscopy is essential. If fibreoptic intubation is possible it should always be preferred[14]. When patients has Glasgow Coma Scale of 8 or less intubation and mechanical ventilation for both airway control and control of ICP are required[21].

The ABC (airway, breathing, circulation) of resuscitation is always the first priority and proves life-saving for both the parturient and the fetus[10].

Burn injuries

Burns, though rare during pregnancy, present a unique medical problem. The mother and fetus are at great risk for fluid loss, hypoxemia, and sepsis. Fluid replacement, respiratory support, and initial wound care are the emergency management goals in pregnant burn patients. The loss of fluid through the denuded surface can be massive, and the amount often is underestimated in pregnant patients. The burns may be due to thermal or electrical cause.

Thermal injury: Occurs in 5-10% of pregnant women. The rule of nine is used to determine the percentage of total body surface area (TBSA) involved, keeping in mind that the large abdominal surface in near term patients counts for a large percentage of TBSA[4]. Another method is to equate the number of palmer surfaces the burn entails, each palmer surface being equal to 1.25% of body surface. During late pregnancy, 5% is added if the anterior abdomen is involved[9]. The fetal outcome is determined by the general physical condition of the woman and the TBSA involved[4].

Inhalation injury should be suspected in patients with history of exposure to closed-space fire, facial injury, carbonaceous material in the oropharynx, or respiratory symptoms. There may be interstitial oedema on chest x-ray film, a carboxyhaemoglobin level greater than 10%, or abnormal arterial blood gas levels.

Fetus is at a high risk during smoke inhalation during pregnancy due to its relatively hypoxic state (i.e. normal umbilical vein PaO_2=27 mmHg). Inhalation injury leads to impaired maternal ventilation (eg, upper airway obstruction from oedema), increased diffusion distance (eg. interstitial alveolar edema), and acute functional anemia from carbon monoxide poisoning. Carboxyhemoglobin (due to carbon monoxide poisoning) values less than 15% usually are well tolerated, whereas values greater than 30% cause severe maternal syncope and fetal death[11].

However, the signs and symptoms of inhalational injury may not be present until several hours post-exposure. Major burn can alter pulmonary function even in the absence of direct lung injury[4].

Electrical injury: Injury occurs due to direct effect of heat generated by the current as well as associated trauma. The type of current, its path through the body, and voltage determine the type and extent of injury. Most victims of electrical injury have multisystem trauma due to violent muscle contraction, skeletal fractures due to fall, and neurologic damage. Since the amniotic fluid is an excellent conductor of electricity, the fetus is at greater risk than the mother[4].

Domestic and sexual abuse

Incidence of domestic violence varies from 5% to 20%. Pregnancy complications, preterm delivery low

birth weight, and substance abuse were more common in pregnant women suffering domestic violence. Further, the abuse is recurrent. Management is similar to blunt trauma[11].

Management of trauma and injuries during pregnancy

Management of the pregnant trauma patient entails management of both mother and the fetus. Maternal wellbeing is of the primary concern. Fetal health is of secondary importance except where perimortem caesarean section may be necessary. The management does not vary widely from that of a nonpregnant patient except for the fact that one should keep physiological changes of pregnancy in mind. Fetal well being is tied with the maternal health. Hence, treatment of mother ensures the fetal management[4].

Prehospital and initial resuscitation[22]

It involves ABC of primary treatment. Secure the airway and provide respiratory support with supplemental oxygen through nasal cannula, mask, or endotracheal intubation as necessary. Respiratory alkalosis is physiological in pregnant patients. Further, pregnancy being hypervolemic state, clinical signs of shock might not appear before loss of approximately two litres of blood. Hence, two large bore intravenous lines should be established and crystalloids rushed to maintain intravascular volume. Blood investigations as necessary, including a complete blood cell count, a type and cross-match, and a baseline coagulation profile should be performed. Intake-output charting is essential. Hence, urinary bladder should be catheterised[4].

Initial neurological assessment should also include that of cervical spine. Lateral x-ray cervical spine may be done if deemed necessary. When the first neurological examination is performed, the right hip of the patient is elevated. After ruling out any vertebral or neurological damage, further assessment is done with the patient in the left lateral position, to prevent severe supine hypotension[4].

Post-resuscitative measures[4,11]

After initial stabilisation of the patient the secondary survey is initiated. Diagnostic peritoneal lavage is done in the midline well above the fundus of the uterus. Assess for uterine irritability, fundal height and tenderness, fetal heart tones, and fetal movements. Cervical effacement and dilation, fetal presentation and the relationship of the fetal presenting part to the ischial spines should also be noted.

In cases suggesting premature labour or antepartum haemorrhage (presence of vaginal bleeding, uterine irritability, abdominal tenderness, pain or cramps), evidence of hypovolemia, changes in or absence of fetal heart tones, hospital admission is mandatory. Fetal monitoring should be continued throughout the resuscitation and postresucitation as deemed necessary.

Exploratory laparotomy in trauma is indicated in cases with positive findings on lavage, free air under the diaphragm (before lavage), progressive abdominal distention with a declining haematocrit, or abdominal wall disruption or perforation. Intraoperative management depends on the type of injury.

Fetal-maternal bleeding can occur with relatively minor trauma. The Rh antigen status of the mother should be considered and anti-D immunoglobulin administered as indicated (300μg).

In-utero fetal transfusion may be considered when the fetus is very immature, 20-26 weeks' gestation.

Uterus should be examined for any penetrating injury in cases where exploratory laparotomy is done. Where such an injury is present and gestation is more than 25 weeks with evidence of fetal compromise, caesarian section is indicated. A paediatrician experienced in the management of premature infants should attend preterm deliveries. If the fetal lungs show maturity, caesarean delivery is indicated for any penetrating injury to the uterus irrespective of presence or absence of fetal compromise. However, in cases with immature lungs but non compromised fetus, uterine repair with conservative management of pregnancy may be done. The risk of patient going into labour postoperatively is, however, present. In the absence of vaginal bleeding or fetal distress, labour may be suppressed with indomethacin, intravenous ritodrine, or magnesium sulfate.

Penetrating uterine injury at less than 25 weeks gestation should be treated conservatively due to 100% neonatal mortality. Fetal fractures, stab or bullet wounds may heal in utero. Maternal haemorrhage or fetal death in association with a uterine laceration that would preclude labour (eg. a large fundal laceration) may require hysterotomy. In general, vaginal delivery is preferable to hysterotomy in cases of fetal death, even if delivery occurs soon after exploration.

Smoke inhalation, electrical burns, burns of both hands and/or both feet, partial-thickness burns that cover more than 10% of the surface area, or full-thickness burns on more than 2% of the surface area require hospital admission.

The fluid requirements for the first 24 hours after a burn injury are calculated as body surface area burned (%) multiplied by 2-4 ml/kg body weight. Fluid requirements are met with Ringer Lactate. The free-water requirement (i.e. 500 ml) is supplied with 5% dextrose in water. Fifty percent of the replacement fluid is administered in the first 8 hours and the remainder during the next 16 hours. In the next 24 hours, colloids (albumin) are administered to maintain the serum albumin greater than 3 g/100 ml.

Management of a burn patient includes getting an arterial blood sample for gases and carboxy-haemoglobin, as well as a chest radiograph. 100% oxygen is delivered by face mask for at least 3 hours or until the carboxyhaemoglobin level is known. Intubation and mechanical ventilation should be used early in the presence of upper airway obstruction or oxygenation failure.

Sepsis after burns is another major cause of fetal and maternal mortality and morbidity. After cleaning and debridement of the wounds, a topical agent should be applied with a bulky dressing. Silver sulfadiazine cream is used most commonly. However, the sulfa derivative crosses the placenta, displaces bilirubin and thereby can lead to hyperbilirubinaemia in the neonate. Silver nitrate (0.5%) may also be used. However, it requires continuous soaking (i.e. q2h) and a bulky dressing. Tetanus toxoid (0.5 ml) should be administered to all patients with burns and other trauma wherever required.

Vigil during therapeutic interventions[4]

In addition to the routine vital monitoring, monitoring the central venous pressure response to fluid challenge is a useful guide to fluid resuscitation. Further, maternal serum bicarbonate level correlate with fetal outcome and may be monitored.

Fetal heart rate monitoring using stethoscope and fetal Doppler for early recognition of fetal distress is necessary. Inadequate acceleration of fetal heart rate in response to fetal movements, and/or late or persistent decelerations of fetal heart rate in response to uterine contractions indicate fetal hypoxia.

Radiographic studies as indicated should be performed, as the benefits outweigh the risks to fetus.

Basic and advanced cardiac life support[22-24]

For a pregnant patient suffering cardiac arrest the following interventions are required:

1. The patient is placed in left-lateral position (30 degree) to prevent supine hypotension.
2. 100% oxygen is given.
3. An intravenous (IV) access is established above the diaphragm.
4. Maternal hypotension with a systolic blood pressure <100 mmHg or <80% of baseline requires therapy.

Manual left uterine displacement done with the patient supine is as good as left-lateral tilt in relieving aortocaval compression. Since chest compressions are less forceful with left lateral tilt, manual uterine displacement may be used instead. If chest compressions remain inadequate despite lateral uterine displacement or left-lateral tilt, immediate emergency caesarean section should be considered. Chest compressions should be performed slightly higher on the sternum than normally recommended. This is because the diaphragm and abdominal contents are raised by the gravid uterus.

Defibrillation with the recommended ACLS defibrillation doses may be performed. There does remain a small risk of inducing fetal arrhythmias. However, cardio version and defibrillation on the external chest are considered safe at all stages of pregnancy.

Emergency caesarean section

The emergency caesarean section team should be activated at the onset of maternal cardiac arrest. Emergency caesarean section may be considered at 4 minutes after onset of maternal cardiac arrest if spontaneous circulation fails to return[22,24]. This is because delivery within five minutes carries the best chance of fetal and maternal survival. Perimortem caesarean section may be considered even if this limit has been exceeded because several case reports have shown neonatal survival with longer arrest to delivery intervals. Delivery of the infant abdominally might also have resuscitative benefits for the mother by diminishing the fetal-placental mass and improving cardiac return and hence cardiac output[4].

Prophylactic and preventive measures to be adopted

Trauma due to road traffic accidents and domestic violence are preventable. Proper use of seat belt helps decrease maternal and fetal injury and mortality after motor vehicle crashes. The lap belt should be placed below the gravid abdomen, with the shoulder harness off the side of the uterus, between the breasts and over the midline of the clavicle[25-27]. Seat belts placed directly over the uterus can cause fetal injury[28].

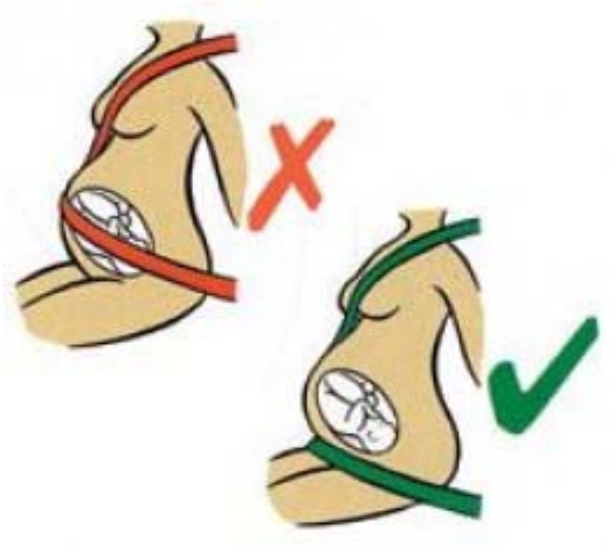

Figure 1. **The incorrect and correct way to wear the seat belt during pregnancy.**

Rabies exposure during pregnancy

The fatality is almost 100% in pregnant patients exposed to rabies and an indeterminate risk to the fetus[29,30]. Even, the fears and concerns regarding rabies immune globulin and killed rabies virus vaccines have not been completely addressed but several studies assessing the safety of this treatment have failed to identify these risks[31-33]. However, a general consensus among the medical fraternity recommends no contraindication to rabies post-exposure prophylaxis (PEP) in pregnancy[34].

There is enough literary evidence which clearly demonstrates the safety of rabies PEP for pregnant patients and no association between treatment and adverse outcomes[31-33]. There is one large study which established that tissue culture-derived vaccines and human immune globulin did not lead to any increased risk for congenital anomalies or to any effect on intrauterine or infant growth or development with a follow up period of 1 year postpartum[33]. Whatever is the outcome of these studies, but a common observation suggests that PEP is generally safe and should follow the same pattern as in general population.

Conclusion

Pregnancy presents a major challenge in trauma care as both the mother and child are at risk and because it is difficult to follow standard protocols in such situation. A pregnancy test is mandatory for all women of child bearing age involved in trauma.

Successful management of such cases requires an interdisciplinary approach. Anaesthesiologists, by virtue of their knowledge about the physiological changes of pregnancy and their familiarity with the procedure of cardio-pulmonary resuscitation, have a greater role in the care and management of these patients. The initial resuscitation should follow advanced trauma life support.

References

1. Bajwa SS, Kaur J, Bajwa SK, Kaur G, Singh A, Parmar SS, Kapoor V. Designing, managing and improving the operative and intensive care in polytrauma. *J Emerg Trauma Shock* 2011; **4**: 494-500.
2. Bajwa SK, Bajwa SJ, Kaur J, Singh K, Kaur J. Is intensive care the only answer for high risk pregnancies in developing nations? *J Emerg Trauma Shock* 2010; **3**: 331-6.
3. Connolly AM, Katz VL, Bash KL, *et al*. Trauma and pregnancy. *Am J Perinatol* 1997; **14**: 331-35.
4. Rudra A, Ray A, Chatterjee S, Bhattacharya C, Kirtania J, Kumar P, Das T, Ray V. Trauma in pregnancy. *Indian J Anaesth* 2007; **51**: 100.
5. Baker BW. Trauma. In: Chestnut DH, editor. Obstetric Anesthesia: Principles and Practice. St Louis: Mosby; 1999. 1041-50.
6. Daponte A, Khan N, Smith MD, Gegiannis E. Trauma in pregnancy. *S Afr J Surg* 2003; **41**: 51-54.
7. Chulu A, Kuczkowski KM. Anaesthetic management of the parturient with massive peripartum haemorrhage and fetal demise. *Anaesthesia* 2003; **58**: 933-34.
8. Clark SL, Cotton DB, Lee W, *et al*. Central haemodynamic assessment of normal term pregnancy. *Am J Obstet Gynecol* 1989; **161**(6 Pt 1): 1439-42.
9. Kuczkowski KM, Reisner LS, Benumof JL. Airway problems and new solutions for the obstetric patient. *J Clin Anesth* 2004; **49**: 214-18.
10. Kuczkowski KM. Trauma in the pregnant patient. *Current Opinion in Anaesthesiology* 2004; **17**: 145-50.
11. Mahoney B, Schwaitzberg SD, Newton ER. Trauma and pregnancy. Medscape references.
12. Mazze RI, Kallen B. Reproductive outcome after anesthesia and operation during pregnancy: a registry study of 5405 cases. *Am J Obstet Gynecol* 1989; **161**(5): 1178-85.
13. Duncan PG, Pope WD, Cohen MM, Greer N. Fetal risk of anesthesia and surgery during pregnancy. *Anesthesiology* 1986; **64**(6): 790-4.
14. Kuczkowski KM, Fouhy SA, Greenberg M, Benumof JL. Trauma in pregnancy: anaesthetic management of the pregnant trauma victim with unstable cervical spine. *Anaesthesia* 2003; **58**: 822-6.
15. Connolly AM, Katz VL, Bash KL, McMahon MJ, Hansen WF. Trauma and pregnancy. *Am J Perinatol* 1997; **16**: 331-6.
16. Baerga-Varela Y, Zietlow S, Bannon MP, Harmsen WS, Ilstrup DM. Trauma in pregnancy. *Mayo Clin Proc* 2000; **75**: 1243-48.

17. Poole GV, Martin JN Jr, Perry KG Jr, Griswold JA, Lambart CJ, Rhodes RS. Trauma in pregnancy: the role of interpersonal violence. *Am J Obstet Gynecol* 1996; **174**: 1873-8.

18. Kissinger DP, Rozycki GS, Morris JA Jr, Knudson MM, Copes WS, Bass SM, *et al*. Trauma in pregnancy: predicting pregnancy outcome. *Arch Surg* 1991; **126**: 1079-86.

19. Ali J, Yeo A, Gana TJ, McLeitan BA. Predictors of fetal mortality in pregnant trauma patients. *J Trauma* 1997; **42**: 782-85.

20. Stone IK. Trauma in the obstetric patient. *Obst and Gynecol Cl N Am* 1999; **26**: 459-67.

21. Stone IK. Trauma in the obstetric patient. *Obst and Gynecol Cl N Am* 1999; **26**: 459-67.

22. Bajwa SK, Bajwa SJ. Delivering obstetrical critical care in developing nations. *Int J Crit Illn Inj Sci* 2012; **2**: 32-9.

23. Bajwa SK, Bajwa SJ, Sood A. Cardiac arrest in a case of undiagnosed dilated cardiomyopathy patient presenting for emergency cesarean section. *Anesth Essays Res* 2010; **4**: 115-8.

24. Hoek TLV, Morrison LJ, Shuster M, *et al*. Cardiac Arrest in Special Situations: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010; **122**: S829-61.

25. Jacob S, Bloebaum L, Shah G, Varner MW. Maternal mortality in Utah. *Obstet Gynecol* 1998; **91**: 187-91.

26. Pearfman MD, Klinich KD, Schneider LW, Rupp J, Moss S, Ashton-Miller J. A comprehensive program to improve safety for pregnant women and fetuses in motor vehicle crashes: a preliminary report. *Am J Obstet Gynecol* 2000; **182**: 1554-64.

27. Hyde LK, Cook LJ, Olson LM, Weiss HB, Dean JM. Effect of motor vehicle crashes on advance fetal outcomes. *Obstet Gynecol* 2003; **102**: 279-86.

28. ACOG Educational Bulletin. Obstetric aspects of trauma management. *Int J Gynecol Obstet* 1999; **64**: 87-94.

29. Rupprecht CE, Gibbons RV. Clinical practice: prophylaxis against rabies. *N Engl J Med* 2004; **351**: 2626-35.

30. Centers for Disease Control and Prevention. Recommendations of the Advisory Committee on Immunization Practices (ACIP). Human rabies prevention-United States. *MMWR Recomm Rep* 1999; **48**(RR-1): 1-21.

31. Chutivongse S, Wilde H. Postexposure rabies vaccination during pregnancy: experience with 21 patients. *Vaccine* 1989; **7**: 546-8.

32. Chutivongse S, Wilde H, Benjavongkulchai M, Chomchey P, Punthawong S. Postexposure rabies vaccination during pregnancy: effect on 202 women and their infants. *Clin Infect Dis* 1995; **20**: 818-20.

33. Sudarshan MK, Madhusudana SN, Mahendra BJ. Post-exposure prophylaxis with purified vero cell rabies vaccine during pregnancy – safety and immunogenicity. *J Commun Dis* 1999; **31**: 229-36.

34. American College of Obstetricians and Gynecologists. ACOG Committee opinion. Immunization during pregnancy. *Obstet Gynecol* 2003; **101**: 207-12.