OBSTETRICS

Trauma in pregnancy: an updated systematic review

Hector Mendez-Figueroa, MD; Joshua D. Dahlke, MD; Roxanne A. Vrees, MD; Dwight J. Rouse, MD, MSPH

Although its precise incidence is not known, trauma is estimated to complicate approximately 1 in 12 pregnancies and is the leading nonobstetric cause of maternal death. Trauma has fetal implications as well, and has been reported to increase the incidence of spontaneous abortion (SAB), preterm premature rupture of membranes, preterm birth (PTB), uterine rupture, cesarean delivery, placental abruption, and stillbirth. In a 16-state fetal death certificate study conducted over 3 years, the rate of fetal death from maternal trauma was calculated to be 2.5 per 100,000 live births, with placental abruption as a major contributing factor. By one estimate, as many as 1 in 3 pregnant women admitted to the hospital for trauma will deliver during her hospitalization. Clearly the rate will vary depending on the criteria used for hospitalizing pregnant women with trauma. While pregnancy per se does not appear to increase morbidity or mortality due to trauma, the presence of a gravid uterus does alter the pattern of injury. Although the literature on trauma in pregnancy is quite extensive, unbiased estimates of the overall impact of trauma on maternal and fetal outcomes are scarce, and the optimal means of monitoring and treating pregnant women who have suffered trauma remain uncertain. The purpose of this report is to present a concise review of the most recent data (since 1990) on the overall incidence, risk factors, outcomes, and management approaches for the many different types of trauma encountered during pregnancy.

Materials and methods

A systematic review was prepared according to the Quality of Reporting of Meta-analysis standards. We conducted a search of the PubMed database (January 1990 through May 2012) using the key words “trauma” and “pregnancy” along with key words for mechanism of injury including “motor vehicle accident/crash,” “burns,” “falls,” “slips,” “accidental overdose,” “domestic violence,” “suicide,” “homicide,” “penetrating abdominal wound,” and “intentional overdose.” To identify the most appropriate management strategies, the key words “management,” “KB stain,” “ultrasound,” “CT scan,” “fetal monitoring,” and “perimortem cesarean section” were also utilized in the search (Table 1). Only English-language publications were included. The size and quality of the articles reviewed varied considerably depending on the injury. We selected studies for this review that included the largest number of patients and that were population-based and/or prospective. Case reports and case series were used only when more robust studies were lacking. We considered all reports concerning trauma in pregnant women regardless of obstetrical (eg, gestational age, plurality) or demographic (eg, maternal age, race) characteristics. All publications meeting inclusion criteria were assessed for quality by 2 authors (H.M.-F., J.D.D.) who independently abstracted information on incidence, risk factors, outcomes, monitoring methods, and various treatment schemes. When available, we recorded incidence rates, relative risk, and 95% confidence intervals (CIs) for adverse outcomes. This systematic review is exempt from institutional review board approval because of the nature of the research design (review article).

Results

We reviewed a total of 1164 abstracts and included 225 in this review, of which only 17 had a prospective design (Table 1). Table 2 contains reported (and in some cases calculated) prevalence rates for the various mechanisms of trauma.
Table 3 presents the characteristics of the largest trauma studies. Unintentional trauma accounts for a large portion of major trauma during pregnancy, the most commonly encountered form of which is motor vehicle crashes (MVC). The overall incidence rate of MVC during pregnancy has been estimated at around 207 cases per 100,000 pregnancies. It is one of the leading causes of both maternal and fetal mortality, with estimated mortality rates...
### TABLE 3

Representative studies of trauma organized by year of publication (1990 through 2012)

<table>
<thead>
<tr>
<th>Authors, location (y)</th>
<th>Design</th>
<th>Inclusion</th>
<th>Sample size</th>
<th>Primary outcome: results</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVC</td>
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<tr>
<td>Vivian-Taylor et al,17 Australia (2012)</td>
<td>Retrospective case-control</td>
<td>Hospital admissions after MVC</td>
<td>2147</td>
<td>Incidence of MVC and pregnancy outcomes after MVC: 3.5/1000 maternity admissions, similar outcomes among MVC and non-MVC</td>
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<tr>
<td>Weiss et al,105 Utah (2008)</td>
<td>Retrospective cohort</td>
<td>State Department of Health ER records</td>
<td>7350</td>
<td>Most common types of maternal injury and risks associated with adverse birth outcomes: MVC are most common mechanism of injury; increased risk of preterm labor, placental abruption, cesarean delivery, and delivery of LBW infant</td>
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<tr>
<td>Hyde et al,107 Utah (2003)</td>
<td>Retrospective case-control</td>
<td>State Department of Transportation reports</td>
<td>8938</td>
<td>Likelihood of adverse outcomes after MVC: women in MVC who use seatbelts are not at significantly increased risk of adverse fetal outcomes than women not in crashes; lack of seatbelt use increases risk for LBW infant, excessive maternal bleeding</td>
</tr>
<tr>
<td>Wolf et al,108 Washington (1993)</td>
<td>Retrospective cohort</td>
<td>Police-investigated MVC</td>
<td>2592</td>
<td>Association of seatbelt use on outcome: &gt;20 wks' gestation: no seatbelt use 1.9 times more likely to have LBW baby and 2.3 times more likely to deliver within 48 hours after MVC</td>
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<tr>
<td>Goodwin et al,109 Arizona (1990)</td>
<td>Prospective cohort</td>
<td>Noncatastrophic trauma during second half of pregnancy</td>
<td>250</td>
<td>Association between signs/symptoms and outcomes after MVC, symptoms of contractions, uterine tenderness, and bleeding after MVC are associated with complications</td>
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<tr>
<td>Pearlman et al,10 Michigan (1990)</td>
<td>Prospective cohort</td>
<td>Women who suffered trauma during pregnancy</td>
<td>85</td>
<td>Adverse outcomes after trauma: adverse outcomes are not predicted by injury severity; 4 hours of EFM was sensitive but not specific in detecting immediate adverse outcomes</td>
</tr>
</tbody>
</table>

### Other forms of trauma

<table>
<thead>
<tr>
<th>Authors, location (y)</th>
<th>Design</th>
<th>Inclusion</th>
<th>Sample size</th>
<th>Primary outcome: results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vladutiu et al,26 North Carolina (2010)</td>
<td>Prospective cohort</td>
<td>Questionnaire about frequency and duration of physical activity</td>
<td>1469</td>
<td>Injuries from physical activity and exercise: injuries rate of 3.2/1000 physical activity hours and 4.1/1000 exercise hours</td>
</tr>
<tr>
<td>Dunning et al,23 Ohio (2010)</td>
<td>Retrospective cohort</td>
<td>Survey after delivery within 2 months</td>
<td>3997</td>
<td>Rate, risk factors, and characteristics of falls: falls reported in 27%; age 20-24 y with 2-fold increase in falls; most falls occurred indoors, involved stairs, &gt;3 feet</td>
</tr>
<tr>
<td>Petrone et al,29 California (2011)</td>
<td>Retrospective case-control</td>
<td>Trauma admissions</td>
<td>291 blunt, 30 penetrating trauma</td>
<td>Mechanism of injury, injury severity score, abdominal Abbreviated Injury Scale, gestational age, maternal and fetal mortality; penetrating trauma had higher maternal mortality, fetal mortality, and maternal morbidity</td>
</tr>
<tr>
<td>Palladino et al,31 United States (2011)</td>
<td>Retrospective case-control</td>
<td>National Violent Death Reporting System</td>
<td>94 suicides, 139 homicides</td>
<td>Deaths attributable to homicide or suicide: pregnancy-associated suicide 2.0/100000 live births, homicide 2.9/100000 live births; 54% of suicides and 45% of homicides associated with IPV</td>
</tr>
<tr>
<td>McClure et al,103 California (2011)</td>
<td>Retrospective case-control</td>
<td>Discharges for intentional poisoning</td>
<td>430</td>
<td>Birth outcomes after intentional acute overdose during pregnancy: incidence rate of 25.87/100,000 person years, greatest in first weeks of gestation; PTB, LBW, congenital heart disease increased</td>
</tr>
<tr>
<td>Gandhi et al,65 California (2006)</td>
<td>Retrospective case-control</td>
<td>Vital statistics discharge database</td>
<td>2132 attempted suicides</td>
<td>Risks for and outcomes after attempted suicide; substance abuse was best identifier of women at risk; increased risk of premature labor, cesarean delivery, need for transfusion, increased respiratory distress syndrome, and LBW</td>
</tr>
</tbody>
</table>

**DV, domestic violence; EFM, external fetal monitoring; EPOS, Edinburgh Postnatal Depression Scale; ER, emergency room; IPV, intimate partner violence; LBW, low birthweight; MVC, motor vehicle crashes; PRAMS, Pregnancy Risk Assessment Monitoring System; PTB, preterm birth; RCT, randomized controlled trial.**

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**Presumably because most MVC are minor and do not result in severe maternal morbidity.**

of 1.4 per 100,000 and 3.7 per 100,000 pregnancies, respectively. Of pregnant women involved in a MVC, 87% receive some sort of medical care and 0.61 pregnancy admissions per 1000 live births can be attributed to MVC. The majority of these admissions occur >20 weeks' gestation. The major risk factor for adverse outcomes during MVC is improper seat belt use: in both front and rear collisions, the impact with the steering wheel can be avoided with proper belt use. Unfortunately, in one study, only half of patients report having received counseling regarding seatbelt use from their prenatal care provider. The use of intoxicants has also been reported as a major risk factor for MVC during pregnancy; 37 of 85 pregnant patients (43.5%) evaluated following an MVC at a major trauma center tested positive for some intoxicant, while another study reported that alcohol was implicated in 45%. As a comparison, in one comprehensive report, 41% of fatal MVC (composed predominantly of nonpregnant victims) were alcohol-related.

The major obstetrical concern with MVC is the strain placed on the uterus, which may result in placental abruption. There are 2 major mechanisms of utero-placental interface failure that have been described in the literature: shear force (strain) failure and tensile failure (“contrecoup” mechanism). The impact of an MVC can generate substantial forward displacement of the uterus. This motion builds both negative pressure and a “contrecoup” effect, 2 mechanisms that along with maternal body folding over the abdomen are enough to markedly increase intraabdominal pressure and result in forces powerful enough to cause placental shearing and subsequent abruption. However, among severely injured women, placental abruption occurs as many as 40% of cases. Although women in severe MVC are at higher risk for pregnancy complications, the greater burden of MVC morbidity in pregnancy may be borne by women in minor MVC, as they predominate. Not surprisingly, pregnant women involved in MVC appear to be at increased risk for cesarean delivery, but the risk of PTB and perinatal death seem to increase only if delivery occurs immediately after MVC, which is fortunately uncommon with an estimated rate of 0.4% <20 weeks and 3.5% thereafter. This increased risk of perinatal death associated with immediate delivery likely reflects the severity of trauma, ie, delivery should never be delayed if clinically warranted in the hopes of improved outcomes.

Literature pertaining to slips and falls during pregnancy is limited. It is known that increased joint laxity and weight gain can affect gait and predispose pregnant women to slips and to falls. Dynamic postural stability decreases with pregnancy, especially during the third trimester, as evidenced by decline in initial sway, total sway, and sway velocity, all measures of stability in response to postural perturbations. Approximately 1 in 4 pregnant women will fall at least once while pregnant. A population-based study found that 79% of hospitalized women after a fall were in their third trimester; among such women, fracture of the lower extremity was the most commonly associated injury. The majority of falls occur indoors and 39% involve falling from stairs. In one of the largest studies to date, Vladutiu et al prospectively evaluated >1400 pregnant women using a structured questionnaire administered at 17-22 weeks and again at 27-30 weeks, and found an overall injury incidence of 4.1 cases per 1000 exercise hours; the majority of these injuries were attributed to falls. Dunning et al reported that 6.3% of all employed pregnant workers fell at work; major risk factors included walking on slippery floors, hurrying, or carrying heavy objects. Schiﬀ, in an analysis of hospitalized pregnant patients admitted after a fall, reported a 4.4-fold increase in preterm labor (95% CI, 3.4–5.7), an 8-fold increase in placental abruption (95% CI, 4.3–15.0), a 2.1-fold increase in fetal distress (95% CI, 1.6–2.8), and a 2.9-fold increase in fetal hypoxia (95% CI, 1.3–6.5) when compared to a randomly selected control group.

Information on burns in pregnancy is limited to case reports and case series. They suggest that the impact of burns depends greatly on the burn depth and the total body surface area affected; as the total body surface area involved exceeds 40%, the mortality rate for both mother and fetus approaches 100% with sepsis being a major contributor. Reports from major burn referral centers have shown that maternal and fetal mortality are significantly increased in cases where smoke inhalation has occurred. Maternal age and trimester of pregnancy of the burn do not appear to affect maternal or fetal outcome and pregnancy does not appear to independently alter maternal survival after severe burns. Burns during the first trimester have been associated with SAB; some authors have speculated that ensuing septicemia after a severe burn may be the predisposing factor to fetal loss. The majority of these losses will occur within 10 days of sustaining the burn. Thermal injury also appears to increase the risk of PTB, although this observation is based on a small retrospective study of 30 patients.

Reports on electrocution during pregnancy are sparse. Among 15 cases of severe electrocution during pregnancy, fetal mortality was 73%, although these case reports may represent a biased sample. In a prospective study that included 31 pregnant women who sustained minor electrical shock, mainly from home appliances, no differences were noted in mode of delivery, birthweight, or gestational age at delivery when compared to controls.

Literature on poisoning during pregnancy relates mostly to intentional poisoning and/or suicide attempts. Accidental poisoning is not as widely reported and its actual incidence unclear. In a study of >400 maternal deaths, only one was attributed to accidental poisoning. Isolated case reports describe accidental overdose of medications in a hospital setting. Intentional trauma during pregnancy accounts for significant maternal-fetal morbidity, increasing the risk of PTB by 2.7-fold (95% CI, 1.3–5.7) and of low birthweight by 5.3-fold (95% CI, 3.9–7.3). The most common form of intentional trauma is domestic violence (DV) or intimate partner violence (IPV). The prevalence of DV/IPV across various populations has been evaluated extensively.
with >60 studies from >20 countries reporting a frequency during pregnancy ranging from 1-57%, consistent with a 22.1% rate reported in the general female population. One explanation for this wide range is the inclusion of emotional, verbal, and/or physical violence within the definition of DV/IPV in some studies. Risk factors associated with DV/IPV during pregnancy are broad and include maternal or intimate partner substance abuse, low maternal educational level, low socioeconomic status, unintended pregnancy, history of DV prior to pregnancy, history of witnessed violence as a child by mother or intimate partner, and unmarried status. Adverse pregnancy outcomes associated with DV/IPV include increased rate of SAB, neonatal intensive care unit admissions, PTB, and low birthweight. Both retrospective and prospective studies have reported a strong association between peripartum depression and DV/IPV.

In a prospective cohort of 13,617 maternal fetal dyads followed up for 42 months, Flach et al noted an association between antenatal DV and maternal antenatal (odds ratio, 4.02; 95% CI, 3.4–4.8) and postnatal (odds ratio, 1.29; 95% CI, 1.02–1.63) depressive symptoms. There are no prospective studies or randomized controlled trials evaluating penetrating trauma in pregnancy and we identified only 2 retrospective analyses. In the larger one, comprising 321 patients, penetrating trauma accounted for 9% of all pregnant trauma admissions. Of those, 73% were handgun-, 23% knife-, and 4% shotgun-related. Penetrating trauma in pregnancy is associated with increased fetal mortality (as high as 73%), increased hospital stay, and complications such as ileus when compared to blunt trauma. Awad et al reviewed their experience of selective laparotomy in 14 penetrating trauma cases in pregnancy over a 16-year period during the civil war in Lebanon. In their cohort, fetal mortality occurred in 50% and maternal mortality was noted in 2 cases (14.3%).

In a multistate sample from the National Violent Death Reporting System from 2003 through 2007, Palladino et al estimated the rates of suicide and homicide in pregnancy were about 2.0/100,000 and 2.9/100,000 live births, respectively. In the general population, the respective rates have been estimated at 5.27/100,000 and 12.43/100,000. Suicide accounts for approximately 20% of postpartum maternal deaths. Interestingly, pregnancy may be protective in those women who are otherwise at high risk for suicide or homicide. In a retrospective analysis of vital statistics records in North Carolina from 2004 through 2006, Samandari et al found the suicide rate to be 27% lower in a pregnant cohort and 54% lower in a postpartum cohort compared to a nonpregnant cohort. Homicide rates were similarly 73% lower in the pregnant cohort and 50% lower in the postpartum cohort. Substance abuse appears to be the best identifier for detecting women at risk for suicide. Another major risk factor for attempting suicide, especially during the postpartum period, is fetal or infant death; Schiff and Grossman reported a case-control study of 520 suicide attempts (63% poisoning) and found a 3.1-fold increase in the risk of suicide attempt when fetal or infant death had occurred. Suicide and homicide during pregnancy are often associated with DV/IPV. Similarly, DV/IPV may be a contributing factor in up to 54% of cases of suicide among pregnant women. Cheng and Horon estimated that 54.5% of pregnancy-associated homicides in Maryland from 2003 through 2008 were committed by a current or former partner, while others have reported rates ranging from 45-74%. Unsuccessful suicide attempts have also been associated with adverse pregnancy outcomes. In a review of 2132 suicide attempts in California from 1991 through 1999, women who attempted suicide but were unsuccessful had increased risk of premature labor, cesarean delivery, need for transfusion, increased respiratory distress syndrome, and low birthweight. Suicide attempt by intentional self-poisoning clearly affects both fetus and mother; maternal death occurs in 1.8% of cases after suicide attempts by ingestion of medication.

Management of trauma during pregnancy

When caring for the pregnant patient who has suffered trauma, the primary management goal is to stabilize the condition of the mother, as fetal outcomes are directly correlated with early and aggressive maternal resuscitation. According to the National Center for Injury Prevention and Control, pregnant women >20 weeks’ gestation should be transported to a center that is: (1) capable of undertaking a timely and thorough trauma evaluation; and (2) adept at management of life-threatening injuries. However, whether such transport is safe and feasible will vary depending on the individual circumstances of a given case. The initial maternal evaluation (primary survey) should follow nonpregnant guidelines and include a full trauma history and vital signs assessment as well as displacement of the gravid uterus to one side. Cardiac arrest, loss of an airway, blood pressure <80/40 mm Hg, pulse <50 or >140 bpm, respiratory rate <10 or >24 breaths per minute, or a fetal rate  <110 or >160 bpm should immediately alert the physician of probable catastrophic trauma requiring immediate stabilization and initiation of advanced cardiac life support as well as advanced trauma life support. Intravenous access should be secured and targeted laboratory tests ordered (Figure). In cases of severe hemorrhage, transfusion of fresh frozen plasma, platelets, and packed red blood cells at 1:1:1 ratio lowers the rate of coagulopathy and may improve survival. Medical anti-shock trousers have been used for the prehospital management of trauma patients but they in fact may delay transportation to hospital and worsen outcomes of penetrating trauma to the thorax and abdomen. However, such trousers may have a role in severe postpartum obstetrical hemorrhage.

When possible, joint evaluation of the patient by both the trauma and obstetrical team should be undertaken. This assessment should include an evaluation of the cervical spine, as manipulation with cervical spinal fracture may result in paralysis. The ideal imaging modality dur-
Proposed algorithm for evaluation and management of trauma in pregnancy.

- **BP**, blood pressure; **CBC**, complete blood cell count; **Ctxs**, contractions; **DV**, domestic violence; **FAST**, focused assessment with sonography for trauma; **FHR**, fetal heart rate; **GA**, gestational age; **HR**, heart rate; **IPV**, intimate partner violence; **ISS**, Injury Severity Score; **IV**, intravenous; **KB**, Kleihauer-Betke; **MVA**, motor vehicle accident; **NICU**, neonatal intensive care unit; **O2**, oxygen; **US**, ultrasound.


Peritoneal lavage can be performed during pregnancy. An open technique is recommended after placement of a nasogastric tube and a Foley catheter. Since pregnancy-specific criteria have not been reported, nonpregnant parameters (ie, cell and red blood cell count, amylase concentration) for a positive peritoneal lavage should be used. When treating pregnant burn victims, aggressive fluid resuscitation, respiratory support, and initial wound care become priorities with the ultimate goal of transport to a tertiary care facility. Some authors have advocated for delivery of all fetuses in the second and third trimester if the mother has sustained burns of >50% total surface area because of the associated high mortality rate. Direct inhalation injury can result in significant airway compromise with subsequent hypoxia and should arouse suspicion for carbon monoxide poisoning (Figure).

Diagnostic radiologic imaging in pregnant trauma patients should be undertaken if clinically indicated and not be withheld or delayed because of unfounded fears of fetal effects. The modalities most studied in pregnancy include ultrasound, CT, and magnetic nuclear imaging. Because of the long acquisition time and difficulty in monitoring a critically ill patient while obtaining imaging, magnetic nuclear imaging is utilized substantially less in acute trauma management.

In the pregnant trauma patient, ultrasound is often easily accessible in an emergency department and can provide crucial information such as gestational age, placental location, fetal presentation, and viability. Ultrasound has been proposed as a method of diagnosing placental abruption, although this method has proven to be unreliable in establishing this diagnosis; in one study sensitivity was only 24%. Focused assessment with sonography for trauma is a safe and efficient method for detecting intraperitoneal free fluid and intraabdominal injuries. This targeted ultrasound assesses 4 areas for evidence of free fluid: the subxiphoid; the right upper quadrant; the left upper quadrant; and the suprapubic area. In a large retrospective cohort of >2300 ultrasound examinations, the
sensitivity and specificity for the detection of free fluid and/or intraabdominal injury in pregnant (n = 328) and nonpregnant trauma patients were similar (61% sensitivity and 94% specificity in pregnant, vs 71% sensitivity and 97% specificity in nonpregnant women). Abdominal helical CT allows the evaluation of multiple organ systems in stable patients. A known drawback of CT scan is the fetal radiation exposure of up to 3.5 rads (0.035 Gy) per study and this risk must be weighed against the potential for identifying life-threatening injuries afforded by this powerful imaging modality. Importantly, radiation doses <5 rads (0.05 Gy) are not associated with an increased risk of anomalies, pregnancy loss, or growth restriction.

In catastrophic trauma or when maternal injury is present, a complete blood cell count, coagulation profile, KB test, and type and screen should be obtained. In Rh-negative mothers, the KB test also allows for calculation of the total required dose of Rh immune globulin: 1 vial of 300 μg protects against 30 mL of fetal blood (15 mL of fetal red blood cells). When minor trauma is present, however, these tests do not appear to be predictive of fetal outcomes. The KB test is used in many institutions as a routine component of trauma evaluation. However, the KB test is insensitive and poorly predictive of adverse perinatal outcomes. Placental abruption, or fetal distress is minor trauma or in trauma with absent maternal injury.

When the fetus is deemed viable, continuous fetal monitoring should be initiated as soon as possible, as long as it does interfere with essential maternal diagnostic tests or therapy. If the mother’s condition precludes safe emergent cesarean, continuous monitoring is of limited value. The ideal duration for monitoring has not been established with recommendations ranging from 4-48 hours; the American Congress of Obstetricians and Gynecologists recommends a minimum of 2-6 hours of monitoring post-trauma. A prospective study evaluating 85 women found fetal monitoring for 4 hours to be sensitive but nonspecific for detecting immediate adverse perinatal outcomes. Although placental abruption has been reported to occur up to 24 hours after a traumatic insult, it has not been reported when <1 contraction is present in any 10-minute interval over a 4-hour period. Thus, fetal monitoring can be discontinued after 4 hours if uterine contractions occur less frequently than every 10 minutes, the feto Heart tracing is reassuring, and there is no maternal abdominal pain or vaginal bleeding. Since placent al perfusion and oxygenation depends on maternal cardiopulmonary function, fetal monitoring should continue in cases of adult respiratory distress syndrome, continuous lung injury, or trauma causing maternal cardiac arrhythmia (Table 4).

Perimortem cesarean section, defined as a cesarean section performed in the face of maternal cardiac arrest, can be life-saving for both mother and fetus. In a multicenter retrospective cohort study of 114,952 trauma admissions including 441 pregnant women, 32 emergency cesarean sections had a reported 45% fetal and 75% maternal survival. Survival of both is dependent on multiple factors including the interval between maternal cardiac arrest and delivery, the underlying etiology of the arrest, where the arrest takes place, and the expertise of the team attending to the mother. Based on experimental data and case reports, cesarean delivery may be appropriate in the setting of imminent maternal death or after 4 minutes of properly performed cardiopulmonary resuscitation that has failed to revive the mother, as both infant and maternal survival are increased when cesarean delivery is initiated within 4 minutes of maternal cardiac arrest. Although delivery should ideally occur within 4 minutes of failed maternal resuscitation, this standard can rarely be met in actual practice even in ideal situations. Notably, resuscitation efforts may improve following delivery as a result of diminished aortocaval compression and improved volume return to the heart. Anecdotally, reports of women undergoing cardiopulmonary resuscitation suggest the possibility of improvement in maternal condition following cesarean delivery. However, no evidence exists that cesarean delivery in this setting actually improves rates of maternal survival for any specific condition.

**Comment**

In this systematic review, we evaluated recent data concerning trauma in pregnancy. We note that the available literature is characterized by several limitations. The majority of the studies are retrospective, and the outcomes reported vary widely. In many of the studies, ascertainment bias is a concern, as only the most severe cases of trauma may have been identified. Studies that rely on hospitalized trauma patients may not give an accurate picture of trauma.

**TABLE 4**

<table>
<thead>
<tr>
<th>Considerations specific to management of pregnant women with trauma</th>
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<tbody>
<tr>
<td>- Pregnancy should not lead to underdiagnosis or undertreatment of trauma due to the fears of adverse fetal effects</td>
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<tr>
<td>- When possible, uterus should be displaced to one side laterally</td>
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<tr>
<td>- When fetus is deemed viable, continuous fetal monitoring should be initiated as soon as possible</td>
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<tr>
<td>- Simultaneous (not sequential) evaluation by trauma and obstetrical teams may be indicated</td>
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<tr>
<td>- Personnel trained in difficult intubation should be readily available</td>
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<tr>
<td>- Penetrating injuries are more likely to affect the fetus, especially those anterior and below uterus fundus</td>
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<td>- If a thoracostomy tube is indicated, it should be placed 1-2 intercostal spaces above usual fifth intercostal space landmark to avoid abdominal placement</td>
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<td>- Pelvic fractures do not necessarily preclude vaginal delivery</td>
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<td>- If peritoneal lavage is indicated, an open technique is preferred as is placement of a Foley catheter and nasogastric tube</td>
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<tr>
<td>- In second- and third-trimester burn victims, delivery should be considered if affected total body surface area is &gt;50%</td>
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<td>- Focused assessment with sonography for trauma is reliable during pregnancy</td>
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across gestation, as gravidas suffering trauma when the fetus is viable are probably more likely to be hospitalized. Studies based on administrative data are subject to inaccurate coding. In some studies, control patients were not matched to cases on the basis of relevant characteristics.

With the above limitations in mind, our review leads to the following conclusions. The major determinant of obstetric outcomes after trauma is the severity of injury. DV/IPV and MVC are the most common mechanisms of traumatic injury during pregnancy and substance abuse is a common accompaniment to these forms of trauma. In most cases, management of the pregnant trauma patient should be dictated by the status of the mother. Major trauma causing maternal instability should be initially managed using advanced cardiac life support/advanced trauma life support guidelines and, depending on the nature of the injuries, may require a multidisciplinary approach involving prehospital care, emergency room providers, obstetricians, and a trauma team to achieve the best outcomes. Once the maternal status has stabilized, an improvement in fetal status often follows. Minor trauma (associated with only minor bruising, lacerations, or contusions) can be assessed with limited radiologic, laboratory, and fetal evaluation. More prospective studies are needed to define the optimal approach to the evaluation and treatment of pregnant women who suffer trauma.

### REFERENCES


