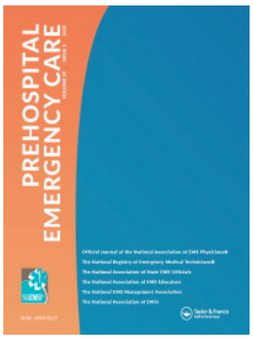

Prehospital Emergency Care

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ipec20

# Prehospital Trauma Compendium: Management of Injured Pregnant Patients– A Position Statement and Resource Document of NAEMSP

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**To cite this article:** Lauren M. Maloney, Ashley N. Huff, Katherine Couturier, Karin A. Fox, John W. Lyng, Christian Martin-Gill, Rickquel P. Tripp, Jenna M. B. White & Francis X. Guyette (12 Mar 2025): Prehospital Trauma Compendium: Management of Injured Pregnant Patients– A Position Statement and Resource Document of NAEMSP, Prehospital Emergency Care, DOI: 10.1080/10903127.2025.2473679

**To link to this article:** https://doi.org/10.1080/10903127.2025.2473679

PREHOSPITAL EMERGENCY CARE
https://doi.org/10.1080/10903127.2025.2473679

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# Prehospital Trauma Compendium: Management of Injured Pregnant Patients–A Position Statement and Resource Document of NAEMSP

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**ABSTRACT**

The assessment and management of critically injured pregnant trauma patients represents a high-risk, low-frequency event. One in every 12 pregnant patients experience physical trauma during their pregnancy, but only 0.1% experience major trauma with an injury severity score (ISS) greater than fifteen. It is crucial that emergency medical services (EMS) clinicians understand the anatomic and pathophysiologic changes that impact morbidity and mortality for pregnant trauma patients so they can effectively provide life-saving interventions and resuscitation for this patient population.

**NAEMSP RECOMMENDS**

- For injured pregnant patients who are at least 20 weeks' gestation (or fundal height at the level of the umbilicus), manual left lateral uterine displacement should be performed whenever possible.
- EMS clinicians should be aware that signs of hemorrhagic shock may be subtle or delayed in injured pregnant patients.
- EMS clinicians should be aware of clinical characteristics unique to the pregnant patient population that require modification of typical lifesaving interventions including hemorrhage control and resuscitation, airway and ventilation management, tension pneumothorax decompression, management of burn and inhalational injuries, and pain management.
- For Traumatic Out of Hospital Circulatory Arrest (TOHCA) in injured pregnant patients of at least 20 weeks' gestation, after correctable causes of TOHCA have been addressed and spontaneous circulation has not returned, if an EMS physician is present, a resuscitative hysterotomy should be initiated ideally within four minutes of maternal arrest. EMS clinicians should understand when an in-hospital resuscitative hysterotomy is indicated, provide a clear and early pre-arrival notification, and expedite transport to the closest appropriate hospital.
- When a pregnant patient is considering refusal of medical aid, EMS clinicians should carefully consider and discuss the potential that life-threatening risks for maternal and fetal morbidity and mortality can occur after even seemingly minor trauma.
- EMS clinicians should promote conversations regarding injury prevention strategies unique to pregnancy, such as correct seatbelt use.
- EMS clinicians should consider the possibility of intimate partner violence when caring for injured pregnant patients.

**ARTICLE HISTORY**
Received 15 December 2024
Revised 19 February 2025
Accepted 22 February 2025

## Introduction

One in every 12 pregnant patients will experience physical trauma during their pregnancy (1–3). Blunt traumatic injuries (91%) are more common than penetrating traumatic injuries (9%), with the two most common mechanisms of injury being motor vehicle collisions (MVC) and falls (4–10). Among pregnant patients who are injured, only 0.1% experience major trauma, as defined as an injury severity score (ISS) >15 (11,12). Resuscitation of the pregnant patient should remain the first priority as fetal outcomes are directly related to the optimal resuscitation and stabilization of the pregnant patient by minimizing or preventing hypotension, hypoxia, acidosis, and hypothermia (4,13–18). Major obstetrical complications resulting from traumatic injuries include placental abruption, uterine rupture, and direct fetal injury, all of which can lead to fetal demise (1,2, 4,10, 19–23). Fetal demise is estimated to be near 50% following major maternal trauma (12). Following minor injuries, low birth weight

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/10903127.2025.2473679.

and preterm delivery may occur, potentially attributable to occult placental abruptions (11,21, 23–25).

Emergency medical services (EMS) clinicians may feel underprepared to manage pregnant patients with emergent conditions due in part to their infrequent clinical exposure to this population and limited initial and continued medical education devoted to obstetrics (26–28). This position statement and resource document aim to emphasize lessons learned from current literature that will have the greatest impact on survival for these high-risk, low-frequency patient encounters.

## Methods

### Search Strategy

We performed a rapid review with a structured search of the literature using guidance developed for the National Association of EMS Physicians (NAEMSP) Prehospital Trauma Compendium (29). The common search strategy identified literature relevant to EMS, and trauma, and was further refined to include cesarean section, hysterotomy, obstetrics, and pregnancy to address the individual topics of this review. We searched PubMed on February 22, 2023, for literature published from inception to February 22, 2023. The final search strategy is provided in the Supplemental Table. Non-English and non-human subjects' literature were electronically excluded as part of the search strategy.

### Topic Areas of Focus

We developed four key questions which generated various topic areas of focus on which to inform the literature review. These were: (1) What is the general approach for EMS clinicians when managing pregnant trauma patients? (2) Among pregnant trauma patients, what standard prehospital interventions are associated with improved patient outcomes? (3) Among pregnant trauma patients, what prehospital interventions unique to pregnancy are associated with improved patient outcomes? (4) What injury prevention strategies are associated with improved outcomes for pregnant patients?

### Screening of Literature

Screening of titles and abstracts and subsequent screening of full text literature was performed by the first author. Additional literature and primary references were identified by hand screening of bibliographies from the PubMed search, standard specialty textbooks, and societal guidelines. Review articles were not included unless a meta-analysis was performed; referenced literature was hand screened for inclusion. Included literature was then grouped by content areas associated with the four key questions.

### Evidence Evaluation

An evidence table was created from the summarization of articles by the first author and subsequently reviewed by the supporting authors (Table 1). Due to resource limitations no risk of bias assessment or grading of the literature was performed.

### Development of Recommendations

The writing group developed recommendations based on the literature review. Recommendations were initially drafted by the first author, and then reviewed and revised by the supporting authors until a consensus was reached. The final recommendations were reviewed by the NAESMP Standards and Clinical Practice Committee and approved by the NAEMSP Board of Directors. The American College of Obstetricians and Gynecologists reviewed these recommendations in December 2024 and supports the value of this clinical document as an educational tool. The final resource document was submitted for standard peer review.

## Results

### Literature Review

After executing the initial literature search strategy, 213 articles potentially relevant to prehospital management of pregnant trauma patients were identified. These articles were screened as detailed in the literature review flow diagram (Figure 1), and 78 reports were subsequently included in the body of evidence from which our recommendations were developed.

### Evidence Synthesis

Table 1 summarizes the evidence from the 78 papers included in our evidence review. These included 11 case reports, 5 case series, 3 observational case-control studies, 35 observational cohort studies, 2 reviews with aggregate statistical analysis performed, 20 clinical practice guidelines, 1 simulation study, and 1 clinical trial.

## Discussion

### General Approach for EMS Evaluation of Pregnant Trauma Patients

#### For Injured Pregnant Patients Who Are at Least 20 Weeks' Gestation (or Fundal Height at the Level of the Umbilicus), Manual Left Lateral Uterine Displacement Should be Performed Whenever Possible

When evaluating any patient capable of becoming pregnant, EMS clinicians must consider the possibility of pregnancy (14,25). Pregnancies determined to be at least 20 wk' gestation, either by history or by palpation of the uterine fundus at or above the level of the umbilicus, should trigger EMS clinicians to perform pregnancy-specific interventions. Manual lateral uterine displacement from the patient's right toward the patient's left side is the most important pregnancy-specific intervention (4,15,25). This is the most effective positioning technique to relieve aortocaval compression by

**Table 1.** Evidence Table.

| Author, Year | Topic addressed* | Article type | Findings or description |
|---|---|---|---|
| ACOG, 2012 | IPV | clinical practice guideline | Committee opinion on intimate partner violence from the American College of Obstetricians and Gynecologists |
| ACOG, 2016 | RMA | clinical practice guideline | Committee opinion on how to navigate refusal of medically recommended treatment by pregnant patients from the American College of Obstetricians and Gynecologists |
| ACOG, 2019 | GA, AM, RH | clinical practice guideline | Practice bulletin about critical care in pregnancy from the American College of Obstetricians and Gynecologists. |
| ACOG, 2019 | AM, PM | clinical practice guideline | Practice bulletin about obstetrical analgesia and anesthesia from the American College of Obstetricians and Gynecologists. |
| Ahmad, 2020 | AM | clinical practice guideline | Guidelines from the Difficult Airway Society about the decision-making, preparation, and practical performance of awake tracheal intubation. |
| Ali, 1997 | GA | observational cohort study | Retrospective review of pregnant trauma patients with ISS ≥12 admitted to two hospitals in Toronto, Canada, to evaluate for predictors of fetal mortality (ISS, blood loss, placental abruption, presence of disseminated intravascular coagulation). |
| Apfelbaum, 2022 | AM | clinical practice guideline | Practice guidelines from the American Society of Anesthesiologists about difficult airway management. |
| ASA, 2016 | AM | clinical practice guideline | Practice guidelines from the American Society of Anesthesiologists and the Society for Obstetric Anesthesia and Perinatology about the anesthetic management of pregnant patients during labor, nonoperative delivery, operative delivery, and aspects of analgesia. |
| Atkinson, 2013 | PB | case report | Case report of the management of a 20 wk' pregnant patient involved in a motor vehicle collision who sustained an open book pelvic fracture requiring external fixation. |
| Bagou, 2022 | GA | clinical practice guideline | Recommendations from a working group in France who used GRADE methodology to analyze available literature about the management of urgent obstetrical emergencies outside of the maternity ward. |
| Barraco, 2010 | GA | clinical practice guideline | Clinical practice guidelines from the Eastern Association for the Surgery of Trauma about the management of pregnant trauma patients. |
| Battaloglu, 2016 | IPV | observational cohort study | Retrospective review of a national trauma registry in the United Kingdom for pregnant patients to evaluate the epidemiology of pregnancy and the obstetric complications encountered in the management of pregnant trauma patients. Pregnant trauma patients experienced higher rates of interpersonal violence than age-matched non-pregnant female trauma patients. |
| Battaloglu, 2017 | GA, AM, TH, BT, TXA, PB | clinical practice guideline | Consensus guideline for the prehospital management of pregnant trauma patients. |
| Battaloglu, 2017 | RH | clinical practice guideline | Consensus guideline for performing prehospital RH during traumatic OHCA. |
| Berry, 2023 | BT, TXA, TQ | clinical practice guideline | A joint position statement about prehospital hemorrhage control and hemostatic resuscitation supported by the National Association of EMS Physicians, American College of Surgeons Committee on Trauma, and the American College of Emergency Physicians. |
| Bloomer, 2011 | RH | case report | Case report describing prehospital RH during atraumatic OHCA for 38 wk' gestation in Australia. |
| Bowers, 2001 | RH | case report | Case report describing prehospital RH during traumatic OHCA for 37 week's gestation in the United States. |
| Braverman, 2022 | BT | case series | Descriptive summary of the first three years of a prehospital and in-hospital whole blood transfusion program in Texas, including a discussion of the risk of isoimmunization and subsequent mitigation strategies. Transfusion recipients included females of childbearing potential, and indications for transfusion included obstetrical hemorrhage. |
| Cardigan, 2022 | BT | simulation | Modeled the theoretical risks of harm of prehospital transfusion of group O D-positive RBC components to trauma patients in England. |
| Chibber, 2015 | GA, SB | observational cohort study | Retrospective review of pregnant patients injured in motor vehicle accidents presenting to a tertiary care hospital in Kuwait to evaluate pregnancy outcomes and seatbelt usage. Only 45% of women reported prenatal care provider counseling for seat belt usage. Of the 728 included women, only 21% were using seatbelts; these women sustained only minor injuries with no poor maternal or fetal outcomes, as compared to placental abruption, preterm labor, uterine rupture, and maternal cardiac arrest. |
| Dahmus, 1993 | GA | observational cohort study | Retrospective review of pregnant trauma patients following non-catastrophic blunt abdominal trauma presenting to a hospital in Tennessee to evaluate for ways to predict maternal and fetal morbidity. Placental abruption occurred in 2.6% of the study population. |
| Dalton, 2023 | RMA | observational cohort study | Retrospective review of pregnant patients who sustained major trauma and were admitted to one of two trauma centers in the United States to evaluate the association between risk factors and adverse pregnancy outcomes. An ISS ≥ 8 was the best cutoff for predicting adverse maternal outcomes; an ISS ≥ 3 was the best cutoff for predicting short-term adverse perinatal outcomes, and an ISS ≥ 2 was the best cutoff for predicting long-term adverse perinatal outcomes. |
| Dijkman, 2010 | RH | observational cohort study | Retrospective review of all RH performed ($n = 12$) in the Netherlands from 1993 to 2008 to evaluate the incidence and case fatality rate of RH. Outcomes overall were poor; more timely application of the procedure could be an important factor in improving outcomes. |
| Distelhorst, 2016 | DHD | observational cohort study | Retrospective observational study in which the Washington State Birth Events Records Database and the Comprehensive Hospital Abstract Recording System were used to determine all hospitalized injured patients to evaluate the association of treatment in a designated trauma hospital vs a non-trauma hospital on maternal and neonatal outcomes. Treatment of injured pregnant patients at designated trauma hospitals was associated with improved birth outcomes such as decreased odds of preterm labor, gestational age <37 wk and low birth weight. |
| Distelhorst, 2017 | DHD | observational cohort study | Retrospective observational study in which the Washington State Birth Events Records Database and the Comprehensive Hospital Abstract Recording System were used to evaluate the effect of the hospital's trauma designation level as it relates to birth outcomes for injured pregnant women. An increased odds of preterm labor of injured pregnant women treated at higher level trauma hospital was observed, as well as an increased odds of low birth weight among severely injured pregnant women (ISS > 9) treated at higher level trauma centers. |
| Duchateau, 2008 | GA | observational cohort study | Prospective observational study in which a mobile cardiotocometer was used on all consecutive pregnant women cared for by physician-staffed ambulances (911, interfacility) in France. Interpretable tracings were obtained for 81% of patients during the initial examination and 66% of patients during handling and transfer procedures. In 12% ($n = 17$) of patients, cardiotocometer monitoring let to a change in the patient's management. |
| El Kady, 2004 | RMA | observational cohort study | Retrospective observational study of women hospitalized for trauma in California to evaluate the occurrence rates, outcomes, risk factors, and timing of obstetrical delivery for trauma sustained during pregnancy. ISS were not predictive of outcomes, and adverse outcomes were seen with ISS < 10, which included placental abruption, uterine rupture, maternal death, and fetal death. |

(*Continued*)

**Table 1.** Continued.

| Author, Year | Topic addressed* | Article type | Findings or description |
|---|---|---|---|
| El Kady, 2005 | IPV | observational cohort study | Retrospective review of maternal discharge records and birth/death certificates in California to evaluate perinatal outcomes of women hospitalized for assault during pregnancy. Women sustaining an assault during pregnancy experienced both immediate (uterine rupture, fetal death, maternal death) and long-term (prematurity, decreased birth weight) negative effects on pregnancy outcomes. |
| Galinski, 2010 | PM | observational cohort study | Prospective review of patients encountered by mobile intensive care units of the emergency services of a Paris suburb to evaluate the prehospital prevalence of pain and identify factors associated with relief of pain. Pain management was especially inadequate in trauma patients and those with obstetrical or gynecological emergencies. |
| Gatti, 2014 | RH | case report | Case report describing prehospital RH during traumatic OHCA for 36 wk' gestation in Italy. |
| Genc, 2023 | RMA, IPV | observational cohort study | Retrospective review of injured pregnant patients presenting to a hospital in Turkey to evaluate the adverse perinatal outcomes that may occur according to the type and severity of the trauma. Of the study population, 30% were exposed to violence. Patients with ISS <9 were noted to have perinatal complications. |
| Gimovsky, 2018 | PM | case series | Retrospective review of two pregnant patients treated with pain-dose ketamine for sickle cell related pain with no reported maternal or fetal adverse effects. |
| Goodwin, 1990 | GA | observational cohort study | Prospective review of patients with non-catastrophic trauma during the second half of pregnancy presenting to a hospital in the United States to evaluate for pregnancy complications including fetomaternal hemorrhage. Placental abruption occurred in 2.4% ($n=5$) of patients. |
| Heesen, 2015 | PM | systematic review and meta-analysis | Systematic review and meta-analysis about the use of ketamine during cesarean section and the resulting desired and adverse effects. It seems that ketamine enhanced post-operative analgesia though descriptions of maternal and neonatal outcomes were limited. |
| Husni, 2000 | IPV | observational cohort study | Retrospective review of patients cared for by Boston EMS to evaluate the prevalence of domestic violence and corresponding prehospital documentation. Approximately 16% of included patients were positive or probable victims of domestic violence. |
| Hyde, 2003 | SB | observational cohort study | A retrospective review of Utah Dept of Transportation motor vehicle crash records and Utah Dept of Health birth and fetal death certificates were evaluated to assess the effect of maternal involvement in motor vehicle crashes on the likelihood of adverse pregnancy outcomes and to estimate the effect of seatbelt use in reducing such outcomes. Pregnant women wearing seatbelts and pregnant women not involved in crashes had similar rates of fetal outcomes. Pregnant women not wearing seatbelts, compared to those wearing seatbelts, were twice as likely to experience excessive maternal bleeding, and 2.8 times more likely to experience a fetal death. |
| Jain, 2015 | GA, AM, TH, RMA, IPV | clinical practice guideline | Clinical practice guidelines from the Society of Obstetricians and Gynecologists of Canada about the management of pregnant trauma patients. |
| Jeejeebhoy, 2015 | GA, RH | clinical practice guideline | Scientific statement from the American Heart Association about Cardiac Arrest in Pregnancy. |
| Klinich, 2008 | SB | observational cohort study | Multi-source in-depth review of motor vehicle crashes involving pregnant patients in the United States to evaluate factors associated with adverse fetal outcomes. Lack of correct seatbelt use was associated with higher risk of adverse fetal outcomes. |
| Kotwal, 2013 | TQ | clinical practice guideline | Proposed changes with supporting evidence for changes in Tactical Combat Casualty Care such as tourniquet use. |
| Kue, 2008 | RH | case report | Case report describing prehospital RH during traumatic OHCA for 36 wk' gestation in the United States. |
| Kupas, 1998 | RH | case report | Case report describing prehospital RH during atraumatic OHCA for 39 wk' gestation in the United States. |
| Kvarnstrand, 2008 | GA | observational case-control study | Retrospective review of the Swedish National Birth Register and the Swedish National Traffic Accident Register to evaluate maternal and fetal mortality rates following motor vehicle collisions during pregnancy. Of the 40 fetal/neonatal deaths included in the study, 40% ($n=16$) were associated with placental abruption. |
| Lenz, 2017 | RH | case report | Case report describing prehospital RH during atraumatic OHCA for 32 wk' gestation in Norway. |
| Lipowicz, 2018 | GA, RH | observational cohort study | Retrospective regional database (Toronto, Canada) review of maternal out-of-hospital cardiac arrest cases. Of the 6 cases of maternal OHCA, only one underwent (or was documented to have underwent) left lateral tilt or left uterine displacement, and of the three to successfully have intravenous access obtained, 100% of intravenous access was above the diaphragm. |
| Luley, 2013 | SB | observational cohort study | Retrospective review of the Duke Trauma Registry for pregnant women > 14 week's gestation who were involved in a motor vehicle accident to evaluate the association between restraint use, race, and perinatal outcomes. The overall rate of placental abruption was 6%. Lack of seatbelt use was associated with increased risk of fetal death (3.5% v 25%, $p=0.18$). |
| Maghsoudi, 2006 | BI | observational cohort study | Prospective review of burned pregnant patients who presented to a hospital in Iran to evaluate patient outcomes. Of the 51 included cases, as the total burned body surface area exceeds 40%, maternal and fetal mortality reaches 100%. |
| Maurin, 2019 | GA, RH | observational cohort study | Retrospective review of maternal out-of-hospital cardiac arrest cases encountered by the Paris Fire Brigade. Of 19,515 OCHA, 16 were in pregnant women, only two of whom survived to 30 days after OHCA. Given the low frequency of these events, memory aids were created to optimize future prehospital care. |
| McGinity, 2018 | BT | observational cohort study | A retrospective review of trauma patients who received massive transfusion protocol at a hospital in Texas to evaluate the subsequent risk of developing isoimmunization in RhD-negative patients. It was estimated that 0.3 RhD-negative women of childbearing age could develop isoimmunization, compared to the estimated 500 women of childbearing age who would die of hemorrhage in the absence of LTO+WB over the same time period. |
| McLelland, 2016 | IPV | observational cohort study | A retrospective review of pregnant women who received care from an Australian ambulance service to evaluate the clinical and socio-demographic details of this patient population. Of the 2,098 pregnant patients encountered, 62 were reportedly victims of interpersonal violence. |
| Melamed, 2012 | RMA | observational cohort study | Retrospective review of all pregnant patients admitted to a hospital in Israel following blunt trauma to evaluate short- and long-term outcomes and risk factors. An ISS ≥ 5 was associated with long-term adverse pregnancy outcomes. |
| Metz, 2006 | SB | case series | Retrospective review of pregnant patients presenting to two trauma centers in Colorado after motor vehicle collisions to evaluate the frequency of placental abruption or fetal compromise after a motor vehicle collision with airbag deployment. Only 2/3 of pregnant women were wearing seatbelts during the motor vehicle collision. Of the 30 included patients, only one was reported to have a placental abruption. |

(*Continued*)

**Table 1.** Continued.

| Author, Year | Topic addressed* | Article type | Findings or description |
|---|---|---|---|
| Mushambi, 2015 | AM | clinical practice guideline | Guidelines from the Obstetric Anesthetists' Association and Difficult Airway Society for the safe management of difficult and failed tracheal intubation of the obstetrical patient during general anesthesia. |
| Nannini, 2008 | IPV | observational cohort study | Retrospective analysis of Massachusetts natality and hospital data to evaluate the patterns of physical injuries reported on hospital visits for assault during pregnancy. Nearly 10% of assaulted women had more than one visit for assault with physical injury in the pregnancy-associated period. |
| Newberry, 2020 | BT | case report | Case report describing prehospital transfusion of whole blood for post-partum hemorrhage in Texas. |
| Newgard, 2022 | DHD | clinical practice guideline | 2021 Field Triage Guideline endorsed by the American College of Surgeons Committee on Trauma, the American College of Emergency Physicians, and the National Association of EMS Physicians, among others. |
| Oude Alink, 2020 | RH | observational cohort study | A retrospective review of neonates born on the day of dispatch who received medical care from Rotterdam HEMS; two infants born *via* prehospital RH. |
| Owattanapanish, 2021 | GA, DHD, RMA, SB | observational case-control study | Retrospective review of pregnant and nonpregnant patients involved in an MVC admitted to a Level 1 trauma center in California. Pregnant patients were less likely to present w tachycardia (heart rate >120) than non-pregnant patients to EMS and the ED. Patients with low ISS were observed to experience adverse pregnancy outcomes. 74% of pregnant patients reported seatbelt use during the MVC. |
| Panchal, 2020 | GA | clinical practice guideline | 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. |
| Parikh, 2015 | BI | scoping review | Review with regression analysis to summarize current literature on early management of burns during pregnancy and offer best practices. |
| Pearlman, 1990 | GA, SB | observational case-control study | Prospective review of injured and non-injured pregnant patients presenting to a hospital in Michigan to evaluate for fetomaternal transfusion. The incidence of placental abruption was 5.9%. Of patients involved in a MVC, 76.5% reported seatbelt use. |
| Pearlman, 2000 | SB | observational cohort study | A multi-pronged approach to study the mechanisms of placental abruption and pregnancy loss caused by motor vehicle collisions. |
| Petrone, 2011 | IPV | observational cohort study | A retrospective review of pregnant trauma patients admitted to one of two level I trauma centers in the United States to evaluate the outcome of pregnant patients sustaining abdominal injuries. A total of 11% of included patients reported domestic assault. |
| Rizzo, 2022 | GA, AM, TH, PM | clinical practice guideline | A Western Trauma Association clinical practice guideline for the management of pregnant trauma patients derived from available expert opinion, case series, and retrospective analysis of trauma data. |
| Roderique, 2012 | BI | case report | A case report of a pregnant patient who experienced a significant inhalation injury during a house fire and received hydroxocobalamin. |
| Rothenberger, 1978 | GA, IPV | observational cohort study | A retrospective review of pregnant patients hospitalized after blunt trauma at a hospital in Minnesota to evaluate patient outcomes. 17% of patients were reported to be victims of assault. |
| Roy, 2020 | PM | case report | A case review of a pregnant patient who sustained a burn injury during the third trimester and received ketamine as part of a pain management strategy. |
| Schiff, 2010 | SB | observational cohort study | Retrospective review of birth and fetal death certificate data with Washington State Patrol crash data to evaluate whether airbag deployment is associated with an increased risk of adverse pregnancy outcomes. Airbags did not appear to be associated with increased risk of most potential adverse outcomes during pregnancy. |
| Schwenk, 2018 | PM | clinical practice guideline | Consensus guidelines about the use of ketamine for analgesia supported by the Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. |
| Sirin, 2007 | SB | observational cohort study | Retrospective review of the Pregnancy Risk Assessment Monitoring System data to evaluate the prevalence of seat belt counseling, seat belt use, and self-reported motor vehicle injury during pregnancy. Reported prenatal care provider counseling for seatbelt use occurred in 49% of prenatal visits. |
| Sperry, 2006 | RMA | observational cohort study | Retrospective review of pregnant trauma patients discharged from a trauma center in Texas to evaluate subsequent pregnancy outcomes. Patients with an ISS of 1 - 4 had an increased rate of preterm delivery compared to patients with an ISS of 0. |
| Stewart, 1993 | IPV | observational cohort study | Survey-based study of women presenting for prenatal care in Toronto, Canada, to evaluate the prevalence of physical abuse during late pregnancy. 6.6% of patients reported physical abuse during the current pregnancy, of whom 66.7% received medical attention. Of these 66.7%, only 2.8% told their prenatal care provider of the abuse. |
| Tommila, 2017 | RH | case series | Retrospective case series describing two prehospital RH during atraumatic OHCA in Finland. |
| Weiss, 2008 | RMA | observational cohort study | Retrospective review using Utah Department of Health computerized databases to describe the demographics and types of injuries of pregnant women presenting to the Emergency Department. Non-severe maternal injuries were observed to result in adverse fetal outcomes. |
| Williamson, 2011 | AM | case series | Prospective review of obstetrical patients receiving rocuronium at induction of general anesthesia who were subsequently monitored with train-of-four testing and were reversed with sugammadex at a hospital in England. |
| Woods, 2020 | RH | case report | Case report describing prehospital RH during atraumatic OHCA for 30 wk' gestation in the United Kingdom. |
| Yu, 2022 | BT | observational cohort study | Survey-based study of females in the United States evaluating the willingness of females to accept urgent but incompatible transfusions considering the potential for future pregnancy complications. At least 90% of adult women were highly likely to be open to accept urgent incompatible blood transfusion during a hemorrhagic emergency when the absolute risk reduction in maternal mortality was at least 4%. |
| Zhou, 2021 | AM | randomized clinical trial | Randomized clinical trial at a hospital in China to determine the efficacy of high-flow nasal oxygenation versus conventional facemask oxygenation on maternal oxygen saturations during RSI for cesarean delivery under general anesthesia. High-flow nasal oxygenation provided higher maternal oxygen saturations immediately after intubation as compared to conventional facemask oxygenation. |

*General Approach (GA), Airway Management (AM), Thoracostomy (TH), Blood Transfusion (BT), Tranexamic Acid (TXA), Tourniquets (TQ), Pelvic Binder (PB). Pain Management (PM), Burn Injury (BI), Destination Hospital Decision (DHD), Traumatic Cardiac Arrest & Resuscitative Hysterotomy (RH), Refusal of Medical Assistance (RMA), Correct Seatbelt Use (SB), Intimate Partner Violence (IPV).

ISS, injury severity score; MVC, motor vehicle collision; OHCA, out-of-hospital cardiac arrest; RSI, rapid sequence intubation; LTO+WB, low titer RhD-positive whole blood.

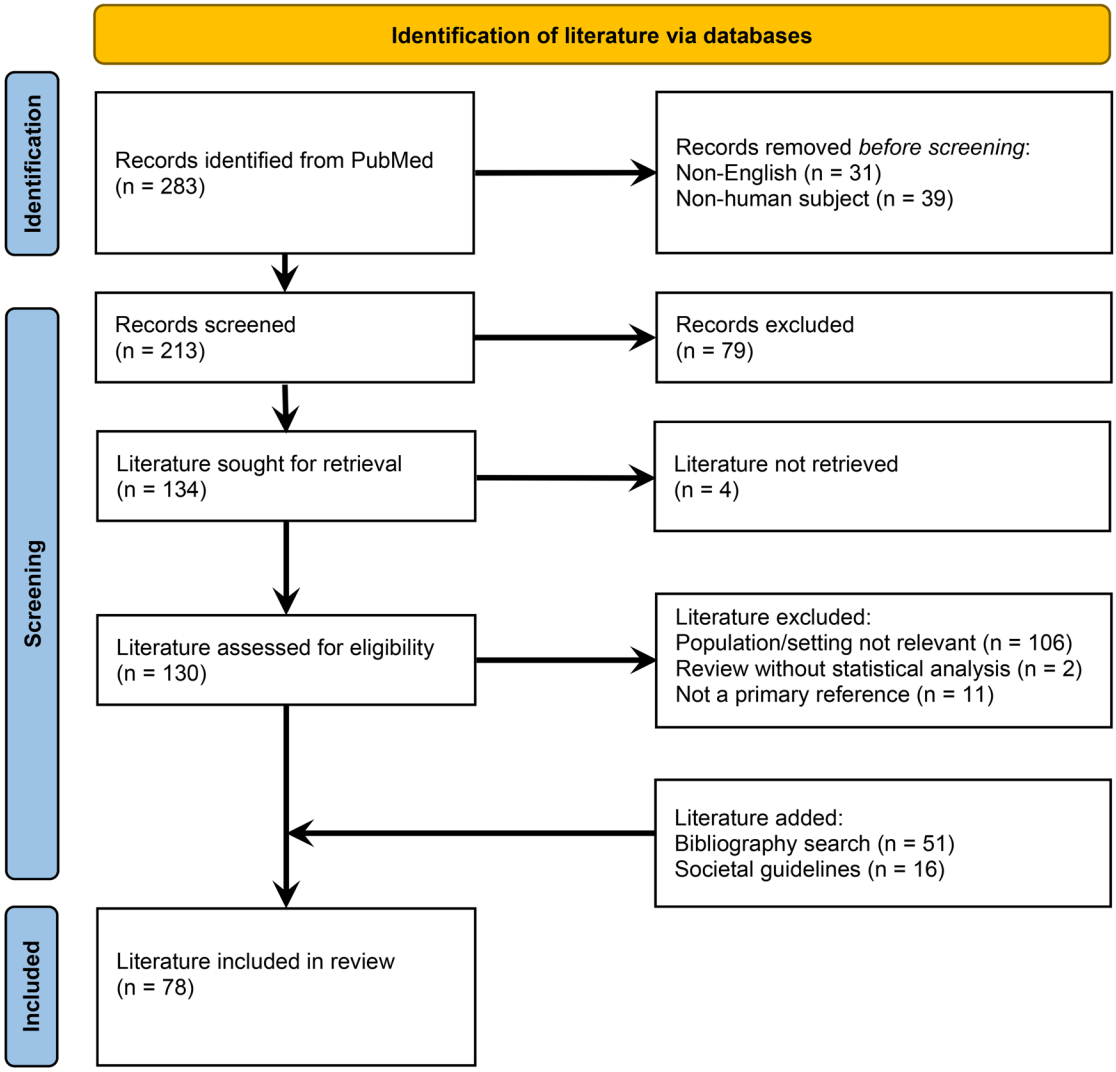


**Figure 1.** Literature search flow diagram.*
*Adapted from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

the gravid uterus which can reduce maternal cardiac output by 30% (4,15, 16,25,30). To encourage compliance with this essential task, "just-in-time" memory aids are recommended (31,32). If lateral uterine displacement is not possible, placing a wedge under the patient's right hip is preferred over remaining fully supine (4,25). Additionally, to avoid vascular congestion from restricted flow through the compressed inferior vena cava, vascular access (Intravenous (IV) or Intraosseous (IO)) should be preferentially obtained in the upper extremities if possible (15,25,33).

### *EMS Clinicians Should be Aware That Signs of Hemorrhagic Shock May be Subtle or Delayed in Injured Pregnant Patients*

The normal physiology of pregnancy produces a hypervolemic, high-flow, and low-resistance state (15). Because an increased plasma volume increases the overall circulating blood volume, a pregnant trauma patient may lose up to 1.5 L of blood before vital signs change (4,15,23). EMS clinicians must appreciate this delay in maternal vital signs revealing maternal and fetal hemodynamic compromise (4,15, 23,34). Though not a focus of our key questions and literature review, emerging evidence suggests a shock index > 1 could be of value when attempting to identify occult hemorrhagic shock in pregnant trauma patients (35–38). However, some studies recommend a lower threshold of >/= 0.9 for identification of shock in the peripartum period, and it is unclear at what shock index value fetal compromise may occur (35–38). Abnormal fetal heart rate tracings are the earliest indicator of impaired hemodynamics (4,15,34). Because uteroplacental vasculature is a maximally dilated, low-resistance system lacking autoregulation, any decrease in maternal perfusion (either from low circulating volume or placental abruption) decreases uteroplacental perfusion, which in turn causes fetal distress from hypoxic acidosis that displays as non-reassuring fetal heart rate patterns on cardiotocographic monitoring (4,15,16). Some degree of placental abruption may occur in up to 50% of pregnant patients with major trauma, and up to 5% of pregnant patients with minor trauma (7,20, 39–42). Because of this, it is strongly recommended that pregnant trauma patients undergo at least four to six hours of cardiotocographic monitoring

in-hospital, even after very minor actual or perceived trauma, as this duration of monitoring should reveal fetal distress from concealed injuries (2,4, 15,17, 23,34, 41,43).

## Evidence Guiding Prehospital Trauma Interventions for Injured Pregnant Patients

EMS Clinicians Should be Aware of Clinical Characteristics Unique to the Pregnant Patient Population That Require Modification of Typical Lifesaving Interventions Including Hemorrhage Control and Resuscitation, Airway and Ventilation Management, Tension Pneumothorax Decompression, Management of Burn and Inhalational Injuries, and Pain Management.

### Hemorrhage Control and Resuscitation

*Tourniquets.* Although evidence specific to pregnant trauma patients is limited, extremity tourniquets should be applied without hesitation when indicated (44). Of the four junctional and truncal tourniquets currently approved by the FDA, only the Abdominal Aortic and Junctional Tourniquet (truncal tourniquet) is expressly contraindicated in pregnancy (45). Of note, pregnancy is an exclusion criterion in many trials evaluating tourniquets, resulting in limited evidence in this population.

*Tranexamic Acid Administration.* Tranexamic Acid Administration (TXA) has been associated with reduced blood loss during cesarean deliveries and improved mortality following postpartum hemorrhage (43,46–49). Although evidence specific to pregnant trauma patients is limited, TXA could be considered in the setting of significant bleeding (25). Prehospital TXA confers the greatest benefit when administered as soon as possible after the injury, up to three hours post-injury (44).

*Blood Transfusion.* When available, prehospital blood transfusion for pregnant patients in traumatic hemorrhagic shock is strongly recommended by consensus guidelines (25,44). Although type O RhD-negative whole blood is not widely available due to limited donors, the benefits of prehospital blood transfusion outweigh the low theoretical risks of isoimmunization, and administration of low titer type O RhD-positive whole blood to pregnancy-capable patients is increasingly accepted (50–54). Consequently, participating trauma systems must ensure patients found to be RhD-negative receive Rho(D) immune globulin and counseling if indicated (44,50–52,55). In addition to traumatic hemorrhagic shock, some programs such as those in Finland and Texas, have introduced prehospital blood transfusion programs for obstetrical-related hemorrhagic shock (51,55,56).

*Prehospital Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA).* The current consensus statement on REBOA describes its use outside the hospital by properly trained physicians as part of a comprehensive system of care; however, evidence reviewing performance of out-of-hospital REBOA for traumatic hemorrhage is limited to case series (44,57–60). Evidence regarding use of REBOA in injured pregnant patients is even more limited to a single case report describing in-hospital REBOA (61). In-hospital use of REBOA for non-traumatic obstetrical hemorrhage is described in case series (62). Due to the significant limitations of this evidence, we are unable to make recommendations regarding use of prehospital REBOA to treat traumatic hemorrhagic shock in pregnant trauma patients.

*Airway and Ventilation Management.* EMS clinicians should expect a pregnant patient to have an anatomically and physiologically difficult airway (63,64). Because oxygen consumption increases by 20% during pregnancy, hypoxia rapidly develops (4,15, 16,25,65). Consensus guidelines recommend all pregnant trauma patients receive supplemental high-flow oxygen during their initial management, which could then be titrated to maintain a maternal oxygen saturation of 94–99% once critical conditions have been ruled out or addressed (2,25). Furthermore, if drug-assisted airway management is necessary, apneic oxygenation may reduce desaturation after induction and paralysis (65–68). To improve functional residual capacity and reduce the risk of aspiration, the head of the stretcher should be elevated to 30 degrees (15,25,65). Increased vascularity and edema of the upper respiratory mucosa heightens the risk of bleeding during intubation, necessitating the availability of large-bore suction and use of a smaller-size endotracheal tube (15,25, 65,66). Traditional rapid sequence intubation and post-intubation sedation and analgesic medications are considered acceptable to use during pregnancy (65,69–71). Increased weight and edema in pregnancy may make finding the landmarks for a front-of-neck airway access challenging; therefore identifying and marking the cricothyroid membrane early in preparation for anticipated intubation challenges is recommended (25,65,66).

Once intubated, ventilator settings should reflect the mild physiologic respiratory alkalosis of pregnancy with a target $PCO_2$ of approximately 30 mmHg in late pregnancy (4,15). It is reasonable to increase the minute volume by 20% during the first trimester, progressively increasing minute volume by 40% at term (64).

*Tension Pneumothorax Decompression.* The gravid uterus causes upward displacement of abdominal organs placing them at risk for injury from pleural decompression interventions. Needle thoracostomy (NT) can be performed using an anterior or lateral approach in pregnant patients; however, if using a lateral NT approach, needles should be placed one to two intercostal spaces higher than usual ($3^{rd}$–$4^{th}$ rather than $4^{th}$–$5^{th}$ ICS). Thoracostomy tube landmarks should be similarly adjusted and placed anterior to the mid-axillary line using ultrasound guidance if available (2,14,25). Further guidance regarding management of tension pneumothorax is provided in a companion paper to this manuscript in the NAEMSP trauma compendium (72).

### Orthopedic Interventions

*Pelvic Fractures.* Although evidence specific to pregnant trauma patients is limited, given the increased pelvic vascular

blood supply during pregnancy, it is reasonable to apply a pelvic circumferential compression device (aka "pelvic binder") at the anatomically appropriate position over the trochanters, directly below the gravid abdomen if a pregnant patient is hemodynamically unstable with a mechanism of injury suspected of an open book pelvic fracture (25,73). If pelvic binders are applied, the patient's legs should also be internally rotated by securing the feet together. Further guidance regarding management of pelvic fractures is provided in a companion paper to this manuscript in the NAEMSP trauma compendium.

***Femur Fractures.*** Evidence specific to management of femur fractures in pregnant trauma patients is limited. Static splinting (non-traction splinting) of suspected femur fractures is reasonable and may be easier to accomplish than traction splinting in pregnant patients. It is reasonable to apply a traction splint to a pregnant trauma patient for appropriate indications like in a non-pregnant trauma patient (e.g., a suspected midshaft femur fracture with neurovascular compromise without contraindicating comorbid extremity or pelvic injuries), presuming no other device-specific contraindications exist and the device can be applied properly with the appropriate landmarks identified. Further guidance regarding management of femur fractures is provided in a companion paper to this manuscript in the NAEMSP trauma compendium.

### Pain Management

Prehospital pain management has been found to be inadequate for traumatic and obstetrical/gynecological emergencies (74). Acetaminophen is considered safe during pregnancy and can be administered orally or parenterally (71). Non-steroidal analgesics like ibuprofen and ketorolac should be avoided as they may cause fetal congenital anomalies (75,76). Opioids are the standard of care for analgesia in trauma and are relatively safe for acute treatment of traumatic injuries in pregnancy. If delivery is imminent, it should be anticipated that the newborn's respiratory drive may be depressed if opiates have been given (70). Limited evidence exists for pain-dose ketamine in pregnancy (71,77–80).

### Burn & Inhalation Injury Management

In general, patients with at least 20% total body surface area burns should undergo fluid resuscitation to counteract fluid loss due to increased skin permeability and evaporation (81). If the surface area of the burn involves the gravid abdomen, the commonly used Rule of 9's will underestimate the total involved surface area. In such cases increasing the fluid resuscitation volume by 30% has been suggested (81). Of note, even mild hypovolemia can cause preterm contractions or labor which requires particular attention be paid to the overall volume status of these patients and could be guided by urine output when possible (18,81).

If carbon monoxide exposure is suspected, maternal pulse co-oximetry level should not be used to exclude carbon monoxide toxicity since carbon monoxide accumulates in greater concentrations in fetal circulation than in maternal circulation; thus, maternal co-oximetry readings will underestimate fetal carbon monoxide levels (81,82). Administration of 100% oxygen *via* non-rebreather mask is the mainstay of prehospital treatment (81,82). If cyanide poisoning is suspected, hydroxocobalamin should be promptly administered (82).

### Destination Hospital Decision

Trauma triage guidelines recommend pregnant trauma patients of at least 20 wk' gestation be taken to a trauma center according to EMS clinician judgment (83). Delayed onset of tachycardia and hypotension in pregnant trauma patients with significant hemorrhage may lead to under-triage of these patients (23). Of note, only Level I and Level II American College of Surgeons verified trauma centers must have continuously available obstetrical surgical coverage (84). Pregnant trauma patients treated at trauma-designated hospitals (as compared to non-trauma-designated hospitals) may have improved outcomes due to immediately available interdisciplinary teams and resuscitation resources (85,86).

## Evidence regarding Prehospital Trauma Interventions Unique to Injured Pregnant Patients

For Traumatic Out of Hospital Circulatory Arrest (TOHCA) in injured pregnant patients of at least 20 Weeks' gestation, after correctable causes of TOHCA have been addressed and spontaneous circulation has not returned, if an EMS physician is present, a resuscitative hysterotomy should be initiated ideally within four minutes of maternal arrest. EMS clinicians should understand when an in-hospital resuscitative hysterotomy is indicated, provide a clear and early pre-arrival notification, and expedite transport to the closest appropriate hospital

The term resuscitative hysterotomy has replaced the term perimortem cesarean to better represent it being a therapeutic intervention intended to reverse cardiac arrest (16,87–89). For gestations of at least 20 wk, a resuscitative hysterotomy should be initiated ideally within four minutes of maternal traumatic arrest as part of the circulatory interventions. However, if more than four minutes has lapsed, a resuscitative hysterotomy should not necessarily be withheld as return of maternal spontaneous circulation and survival of both the neonate and pregnant patient may still depend upon delivery (90). A resuscitative hysterotomy is ideally performed after catastrophic hemorrhage has been controlled, the airway has been secured, and tension pneumothorax and cardiac tamponade have been addressed or ruled out as possible (15,88). If obviously fatal maternal injuries are present, a resuscitative hysterotomy should be performed immediately (15). Performing a resuscitative hysterotomy is standard of care and within the scope of practice of an EMS physician and may be performed in the field if adequate resources are available (15,87–89, 91–99). If transport can be completed within four to five minutes of maternal arrest, a resuscitative hysterotomy may be delayed until hospital

arrival (32,93). Absent an EMS physician or other qualified clinician, EMS clinicians should recognize the above conditions suggesting when an in-hospital resuscitative hysterotomy may be indicated, provide a clear and early pre-arrival notification, and expedite transport to a trauma center (31,32). We agree with the American Heart Association guidance that EMS should direct transport toward a center that is prepared to perform a resuscitative hysterotomy, and that transport should not be prolonged by more than ten minutes to reach a center with more capabilities (33).

If maternal return of spontaneous circulation is achieved after a resuscitative hysterotomy, maternal analgesia and sedation should be provided (88). Although case reports describe the procedure to be relatively bloodless, once return of spontaneous circulation is achieved hemorrhage is likely; direct pressure on wounds, application of hemostatic dressings, and administration of TXA or blood products should be considered (87,88,95).

## Prehospital Guidance for Navigating High-Risk Refusals and Injury Prevention Strategies for Pregnant Trauma Patients

When a pregnant patient is considering refusal of medical aid, EMS clinicians should carefully consider and discuss the potential that life-threatening risks for maternal and fetal morbidity and mortality can occur after even seemingly minor trauma

According to the American College of Obstetricians and Gynecologists, "pregnancy is not an exception to the principle that a decisionally capable patient has the right to refuse treatment, even treatment needed to maintain life" (100). When counseling a pregnant trauma patient and ensuring the patient understands sufficient information about potential injuries and understands the risks of available options, EMS clinicians should specifically highlight that: (1) maternal vital signs may not accurately reflect maternofetal perfusion; (2) seemingly insignificant maternal trauma can cause significant complications which may not be immediately apparent; and (3) small amounts of RhD-positive fetal blood can sensitize the Rh-negative pregnant patient and impact future pregnancies if Rho(D) immune globulin is not administered (2,4, 9–11,15, 21–23,92,101).

### EMS Clinicians Should Promote Conversations regarding Injury Prevention Strategies Unique to Pregnancy, Such as Correct Seatbelt Use

Correct seatbelt use and the presence of airbags are associated with increased maternal and fetal survival following a MVC (39,102–106). The lap belt should be snug across the hips below the gravid abdomen, and the shoulder belt should be across the chest and mid-portion of the clavicle. At least 30% of pregnant patients report not wearing a seatbelt, likely due to discomfort or uncertainty about seatbelt safety during pregnancy. Additionally, less than 50% of pregnant patients reporting receiving counseling about correct seatbelt use during prenatal visits (23,39, 41,107,108).

### EMS Clinicians Should Consider the Possibility of Intimate Partner Violence When Caring for Injured Pregnant Patients

Despite being underreported, nearly 20% of injuries to pregnant patients are the result of intimate partner violence, and of that group, 60% are subjected to repeated episodes of intimate partner violence (4,5, 8,12, 22,109–113). EMS clinicians must therefore consider intimate partner violence when caring for any injured pregnant patient (2,15,114).

## Future Research

The evidence base for caring for pregnant trauma patients is derived almost entirely from case reports and retrospective observational studies. Given infrequent EMS encounters with pregnant trauma patients, adequately powered future prospective clinical trials may be limited. Therefore, EMS clinicians must leverage existing large data sets to encourage as robust and diverse an analysis as possible. Standardized data elements must also be reviewed to ensure that pregnant patients are accurately and equitably represented. For example, the ISS, a widely used grading scale to communicate and compare the severity of traumatic injuries, has not been validated or consistently shown to be predictive of adverse maternal or fetal outcomes (3,6, 11,21–24, 101,115,116).

Strict protections and safeguards are implemented for pregnant patients and their fetuses to protect from harmful interventions and clinical research. Even though they are well-intended, they create challenging conditions for performing research and advancing the science surrounding maternal care in trauma (117). The ability to rapidly confirm pregnancy status in the field would alleviate some of these challenges (118). Moving forward, EMS clinicians must commit to ensuring that pregnant individuals are not automatically excluded from appropriate clinical trials as this may prevent these patients from receiving any benefit the trials may offer.

## Secondary Traumatic Stress Exposure for EMS Clinicians

The relatively low frequency with which EMS clinicians care for pregnant patients who are critically ill, in combination with the high-stress situation of caring for two patients simultaneously, almost certainly elicits an emotional and psychological response from the involved clinicians. The impact of this secondary traumatic stress exposure on the involved EMS clinicians should be considered (93). It is strongly recommended that EMS agencies develop a procedure to 1) acknowledge and recognize when these events occur; 2) gauge the stress level of each EMS clinician involved in these events from their experience; and 3) initiate a pre-planned pathway for individuals to receive informal peer support and/or formal mental health professional counseling. Examples of such programs include EMS Code Lavender, which was launched in response to the performance of a resuscitative hysterotomy, a peer support program created by an air medical program in the southeastern United States, and the FIRECARE program implemented by the Paris Fire Brigade (119–121).

## Considerations for Implementation

Implementation of these recommendations is limited by the appropriate recognition of pregnancy in trauma patients. Education related to these recommendations should include the consideration and evaluation for possible pregnancy and estimating gestational age by assessing the location of the uterine fundus relative to the umbilicus. Further, EMS clinician education regarding the need for alternative or modified clinical interventions is needed.

Some of these recommendations may require increasing the number and/or type of EMS clinicians dispatched to provide care on scene and in transport. Therefore, EMS systems should plan for the need of additional personnel in the management of pregnant trauma patients. For example, the ability to displace the uterus to the left as part of treatment of maternal shock requires the assistance of an additional EMS clinician. An anticipated barrier to performance of a resuscitative hysterotomy is the availability of an EMS physician or other qualified clinician in the field. When such resources are not available, EMS personnel should be educated on appropriate hospital destinations within each EMS system where a resuscitative hysterotomy may be available.

## Limitations

Our review was limited by the scarcity of published literature pertaining to the prehospital care of pregnant trauma patients. Our rapid review approach was further restricted by the screening of publications by a single reviewer. Additionally, while our approach did not incorporate a risk of bias assessment and a grading of the quality of evidence, the preponderance of observational data found in this review suggests an overall low or very low quality of evidence. Many of the included publications did not come from the initial literature search strategy, but rather from hand screening of bibliographies and societal guidelines. Much of the more recent clinical guidance we reviewed was derived from publications in which the pregnant trauma patient population was mixed with other populations. This presented challenges in capturing those publications with the keywords used in our literature search. Additionally, most of the primary literature regularly cited by current textbooks dates back several decades, which is significant given changes and advancements that have occurred in automotive safety, diagnostic capabilities, and EMS clinician capabilities and scope of practice.

## Conclusion

When EMS clinicians care for a pregnant trauma patient, it is imperative to remember that providing optimal maternal resuscitation to prevent or correct hypoxia, hypoperfusion, acidosis, and hypothermia provides the best chances of both maternal and fetal survival. EMS clinicians must maintain awareness that the physiological adaptations of pregnancy can mask early clinical signs of maternal decompensation. EMS clinicians must also recognize important modifications that injured pregnant patients require from standard trauma care including differences in patient positioning and technique modifications for certain life-saving interventions. Efforts should be made to build a more robust scientific evidence base on which to build future recommendations for EMS care of pregnant trauma patients.

## Authorship Statement

CMG and FXG developed the plan for literature review and evidence extraction. All authors assume full responsibility for the collection and integrity of the data. LMM performed the primary evidence extraction and evidence summarization. All authors participated in verifying evidence summarization. LMM wrote the initial draft of the manuscript; all authors participated in editing and reaching a consensus on the recommendations. All authors assume full responsibility for the entire content of the manuscript.

## Declaration of Generative AI in Scientific Writing

The authors did not use a generative artificial intelligence (AI) tool or service to assist with preparation or editing of this work. The author(s) take full responsibility for the content of this publication.

## External Review

The American College of Obstetricians and Gynecologists supports the value of this clinical document as an educational tool, December 2024.

## Updating Procedure

Pursuant to NAEMSP Standards & Clinical Practices Committee procedures and practices, this position statement and resource document will be reviewed and updated five years after its publication. Applicable NAEMSP review and revision practices that are current as of the time of the review will be followed. At a minimum the review process should include a search and synthesis of any new and relevant evidence that is published since the printing of this document.

## Disclosure Statement

No potential conflict of interest was reported by the author(s).

## Funding

This document was developed by NAEMSP without external funding.

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