Faculty of Pre – Hospital Care

Expert Consensus Meeting

Management of Pregnancy and Obstetric Complications in Pre – Hospital Trauma Care

Principal Authors

E Battaloglu, K Porter

Consensus Panel

N Abeysinghe, C Bosanko, C Cox, J Chu, N Crombie, C Leech, R Moss, M Nash, F Plaat, J Ralph, M Russell, M Wyse

Abstract

This consensus statement seeks to provide clear guidance for the management of pregnant trauma patients in the pre-hospital setting. Pregnant trauma patients have certain clinical management priorities beyond that of the non-pregnant trauma patients and if overlooked may be detrimental to maternal and fetal outcomes.

Keywords

Trauma, Injury, Pregnancy, Obstetrics, Pre Hospital, Management

Corresponding Author

Mr E Battaloglu, Academic Department of Clinical Traumatology, Nuffield House, Queen Elizabeth Hospital, Edgbaston, Birmingham, B15 2TH

Email: e.battaloglu@nhs.net

Introduction

Trauma in pregnancy is the leading co-incidental cause of maternal death and remains the most common cause of fetal demise (Petrone, 2011). Many diagnostic and management challenges are present when dealing with the injured pregnant patient. Anatomical and physiological variations of pregnancy need to be understood in order to adapt medical management and overcome the numerous challenges which exist for such patients. The relative unfamiliarity of anatomical and physiological changes experienced in pregnancy means great care must be taken when managing such patients, especially in high energy trauma injuries.

Numerous studies conducted throughout North America have assessed the epidemiology of obstetrics in trauma. Trauma is reported to complicate between 6 – 8% of pregnancies (Hill, 2008), 0.4% require hospital admission (Lavin, 1983) and 0.1% will be victims of major trauma (Injury Severity Score (ISS) >15) (Sperry, 2006). 50% of non-obstetric maternal mortalities are due to trauma (Kissinger, 1991). Fetal mortality is also a considerable issue, with 3 – 7 fetal deaths per 100,000 live births as a result of trauma (Schiff, 2002).

The most common cause of isolated fetal death is due to placental abruption. Placental abruption is theorised to occur either as a result of shearing forces or a "contrecoup" mechanism leading to a separation of the rigid placenta from the elastic uterus. Other causes of fetal demise include spontaneous abortion, uterine rupture and still birth. Reported series demonstrate up to 50% of pregnant patients with major traumatic injuries and as many as 5% with minor injuries will suffer a placental abruption (Mighty, 1994). The result of trauma during pregnancy on the long term health of the fetus, even from minor injury, is a significantly increased risk of pre-term delivery and low birth weight. From North American data, blunt trauma predominates over penetrating injury and road traffic accidents account for the majority of blunt injuries. However, penetrating abdominal injury carries significant risk and studies have demonstrated rates of fetal mortality of 73% and maternal mortality 63% from penetrating trauma (Petrone, 2011). Domestic violence is considered to be widely under-reported and is likely to be the second leading mechanism of injury for trauma in pregnancy.

Definition of Pregnancy in Pre-Hospital Trauma Care

When encountering a female trauma patient between the ages of 10 and 50 years old, there must be a consideration for the potentiality of pregnancy. In order to improve the level of understanding and communication, the terms; potential, early and viable pregnancy shall be used. Potential pregnancy includes all women of child bearing age and should trigger the practitioner to assess in greater detail the likelihood and gestation of pregnancy. Early pregnancy should be used for the women of child bearing age who is or suspected to be pregnancy, with gestation less than 20 weeks. Viable pregnancy shall be the term referring to women with a pregnancy is greater than 20 weeks. Ideally, communication relating to pregnancy should define the approximate age of gestation, for example; 24 weeks, 30 weeks

or 40 weeks, in order to maximise understanding and the relay of information. Estimation of pregnancy gestation can be made through evaluation of uterine fundal height (see Figure 1). Viable pregnancy can be most readily estimated by correlation with whether fundal height is at or above the level of the umbilicus. In the absence of obstetric history, such estimation can be useful in gauging gestation, however if there is any uncertainty or conflicting information, pregnancy should be deemed viable until proven otherwise.

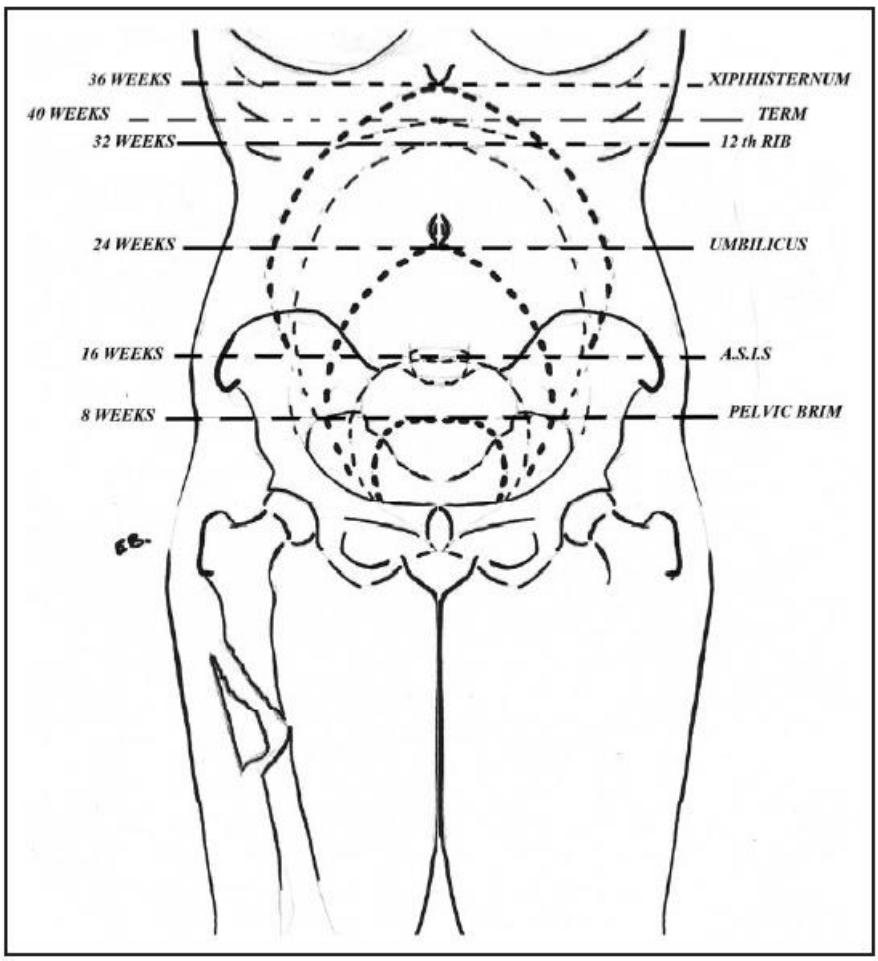

Figure 1. Uterine Size & Fundal Height, in relation to Anatomical Landmarks (Battaloglu, 2015).

Methods

A review of the literature was undertaken prior to the consensus meeting and information was distributed to panel members. Literature was compiled from searches of the Medline Database, using Pubmed and Google Scholar, along with reference to international guideline documents. Search terms included; *Pregnancy, Obstetrics, Trauma, Injury, Fracture, Haemorrhage, Peri-mortem Caeserean Section.*

Hierarchy of Evidence (Shekelle, 1999)

Level of evidence	Type of evidence
Ia	Evidence from systematic reviews or meta-analysis of randomised controlled trials
Ib	Evidence from at least one randomised controlled trial
IIa	Evidence from at least one controlled study without randomisation
IIb	Evidence from at least one other type of quasiexperimental study
III	Evidence from non-experimental descriptive studies such as comparative studies, correlation studies and case-control studies
IV	Evidence from expert committee reports or opinions and/or clinical experience of respected authorities

Grading of recommendations

Grade of recommendation	Type of evidence
A	Based on hierarchy I evidence
B	Based on hierarchy II evidence or extrapolated from hierarchy I evidence
C	Based on hierarchy III evidence or extrapolated from hierarchy I or II evidence
D	Directly based on hierarchy IV evidence or extrapolated from hierarchy I, II or III evidence

Summary of Recommendations

Airway

1. *A recommendation is made for the relative contraindication to NasoPharyngeal (NP) airway insertion in pregnant trauma patients. [D]*
2. *A recommendation is made for the use of a smaller size Endotracheal Tube (ETT) during intubation of the pregnant trauma patient. [C]*
3. *A strong recommendation is made for the use of a 2nd generation supra-glottic airway device as the rescue device of choice following failed intubation. [A]*
4. *A recommendation is given for use of vertical incision over the midline of the neck at the level of the cricothyroid cartilage to enable access to the trachea. [C]*

Breathing

1. *A strong recommendation is given for the provision of supplemental high flow oxygen to all pregnant trauma patients. [A]*
2. *A strong recommendation is given for thoracostomy sites or the insertion of intercostal drains to be made in either 3rd or 4th Intercostal Space anterior to the mid-axillary line. [D]*

Circulation

1. *A recommendation is given for limited reliance to be placed on blood pressure as a marker of hypovolaemia following trauma. [D]*
2. *Examination of the uterus and external genitalia is recommended to complete abdominal evaluation for haemorrhage. [D]*
3. *Manual Uterine Displacement or Left Lateral Tilt Positioning is recommended at all times for the pregnant trauma patient. [D]*
4. *Recommendation is given to aim for the establishment of vascular access above diaphragm in the pregnant trauma patient. [D]*
5. *A recommendation is given for the early administration of blood products in the aggressive volume resuscitation of the pregnant trauma patient. [C]*
6. *A strong recommendation is made for the use of Tranexamic Acid (TXA), as per Standard Operating Procedures (SOP) in trauma patients, for pregnant trauma patients. [B]*
7. *A strong recommendation is made for the use of pelvic binder devices, as per SOPs in trauma, for pregnant trauma patients. [C]*

Disability

1. *Spinal immobilisation precautions are recommended as per SOPs for pregnant trauma patients. [D]*
2. *The placement of adjuncts to achieve sufficient patient tilt should be positioned below any spinal immobilisation devices and be supported along the length of any devices. [D]*

Resuscitation

1. *A strong recommendation is made that Cardiopulmonary Resuscitation (CPR) must be performed in a supine position with manual uterine displacement. [B]*
2. *A recommendation is given for Resuscitative Hysterotomy to be completed as soon as possible following the onset of maternal cardiac arrest and within 15 minutes following witnessed cardiac arrest with ongoing CPR. [D]*

Communication / Voice Procedure

1. *A recommendation is given for the modification of the hand over / interpersonal communication of health care professionals when managing pregnant trauma patients below. [D]*

Transportation & Services

1. *A strong recommendation is made that all pregnant trauma patients should be assessed primarily within the emergency department of the receiving facility and obstetric/paediatric/neonatal services should attend as clinically indicated. [D]*
2. *A recommendation is given for "D15 standard contract for Major Trauma Centres" to include and be mandatory for the provision of "on site or co-located" obstetric services. [D]*
3. *A strong recommendation is given for the adoption of a sophisticated triage tool or review system to operate within all regional trauma networks. [C]*
4. *A recommendation for the adaptation of UK Trauma Triage Tools, when considering pregnant trauma patients is summarised below:*
    a. *Pregnancy <20 weeks; follow normal triage tool pathway.*
    b. *Pregnancy > 20 weeks, otherwise trauma triage negative; attend nearest trauma unit with obstetric services.*
    c. *Pregnancy > 20 weeks, trauma triage positive; attend nearest Major Trauma Centre with available Obstetric Services. [B]*

Recommendations

Airway

1. *A recommendation is made for the relative contraindication to NasoPharyngeal (NP) airway insertion in pregnant trauma patients. [D]*
   Due to the presence of increased oedema in pregnancy, the friable tissues of the nasal mucosa are at higher risk for potential iatrogenic injury during insertion of NP airway devices (Chesnutt, 2004) [IV]. Supporting evidence is limited to anecdotal levels, but founded on proven theory and thus given the recommendation as a relative contraindication. NP airway insertion should only be used if no possible oral airway can be established, for example due to trismus or mandibular trauma. Therefore, the insertion of NP airway devices should be judged according to risk versus benefit and on an individual basis.
2. *A recommendation is made for the use of a smaller size Endotracheal Tube (ETT) during intubation of the pregnant trauma patient. [C]*
   Airway security is of paramount importance for the pregnant trauma patient and due to presence of laryngeal / naso & oropharyngeal oedema in pregnancy, the use of a smaller size ETT may improve rates of successful intubation (Jones, 2012) [III]. There should be a preparation for a reduced threshold, or earlier intubation, in pregnant trauma patients than in the non-pregnant. It should also be considered if there is potential airway compromise and/or an anticipated long transit-time.
   However, proficiency at the skill of endotracheal intubation is mandatory and should not be undertaken by those without the requisite skills or support.
   Recognition must be made of the increased risk of intubation failure in obstetric patients (Suresh, 2010). The incidence of failed intubation in obstetric patients undergoing general anaesthesia was shown to be 1 in 225 (Quinn, 2013). Increasing age, higher BMI, and inclination to record Mallampati score were significant independent predictors of failed tracheal intubation (Quinn, 2013). For every 1 kg/m^2 increase in BMI, there was a 7% increase in the risk of failed intubation. It can only be speculated that intubation the pre-hospital setting for obstetric patients may be more challenging, given unfavourable conditions, lighting, limited assistance, etc.
3. *A strong recommendation is made for the use of a 2^{nd} generation supra-glottic airway device as the rescue device of choice following failed intubation. [A]*
   2^{nd} generation supraglottic airway devices have been demonstrated to be superior to that of 1^{st} generation devices (Cook, 2011) [Ia]. In the series evaluating obstetric anaesthesia, the classical laryngeal mask airway was the most commonly used rescue airway, utilised in approximately two thirds of cases following failed intubation (Quinn, 2013). Due to the range of available devices, and associated effectiveness without sufficient scientific evidential support, no specific device is recommended for airway rescue purposes and should be directed by local policies. Gastric aspiration following intubation in obstetric patients is reported to occur in 1% of patients undergoing general anaesthesia. This is significantly higher than the non-obstetric

population which ranges up to 0.1% incidence rate. Gastric aspiration following failed intubation of obstetric patients is reported to occur in 8% of cases (Quinn, 2013). Aspiration rates following pre-hospital anaesthesia are also reported to be higher than the standard intubation (Lockley, 2013). It is therefore anticipated that the pregnant trauma patient is at high risk for aspiration.

4. *A recommendation is given for use of vertical incision over the midline of the neck at the level of the cricothyroid cartilage to enable access to the trachea. [C]*
   The use of a vertical incision over the midline has been studied in non-obstetric patients and has been demonstrated to increase accuracy of incision placement. Thus, reducing the likelihood of iatrogenic injury or incorrect tube placement when establishing a surgical airway (MacIntyre, 2007 & Paix, 2012) [II]. The increased soft tissue oedema experienced in pregnancy, along with increased adiposity, can result in difficulty identifying key soft tissue landmarks for the placement of the surgical airway. Therefore, if there is an indication for a surgical airway, consideration for use of this optimal vertical incision is recommended. Needle cricothyroidotomy is not recommended as a satisfactory method of oxygenation and should only be attempted if no other resources or options exist, evaluated on an individual basis.

Breathing

1. *A strong recommendation is given for the provision of supplemental high flow oxygen to all pregnant trauma patients. [A]*
   Physiological changes in pregnancy result in a significantly increased oxygen consumption, even at rest, when compared with the post-partum state (Perroll, 1975). This may have an impact on the ability of the pregnant trauma patient to tolerate hypoxic conditions, due to hypovolaemia or thoracic injury. Current British Thoracic Society "Guidelines for emergency oxygen use in adult patients" advocated the use of oxygen for all patients with major trauma or obstetric emergencies. Treatment should be initiated through the use of a reservoir mask at 10 – 15 l/min and aim for oxygen saturation rates with the range of 94–98% (O'Driscoll, 2008) [Ia]. Evidence for the effect of high concentrations of inspired oxygen for patients with hypoxaemia is unquestioned, however increasing strength of evidence is coming to light regarding the potentially detrimental effects of hyperoxaemia. In particular, the literature exploring the physiological and biochemical impact of supplemental oxygen in pregnancy on mother and fetus highlights theoretical harm. Neonatal resuscitation with 100% oxygen is no longer recommended and maternal oxygen supplementation increases requirement for neonatal resuscitation (Kleinman, 2010 & Nesterenko, 2012). However, primary focus must be placed upon the optimal management of maternal health and within pre-hospital environments, where comprehensive patient evaluation can be difficult, supplemental oxygen should not be withheld. Yet, titration of therapy can be considered on an individual basis, in stable patients without critical or suspected critical conditions.
2. *A strong recommendation is given for thoracostomy sites or the insertion of intercostal drains to be made in either 3rd or 4th intercostal space anterior to the mid-*

axillary line. [D]

Due to the position of the uterus within the abdomen, careful anatomical consideration must be given to the position of the diaphragm when performing thoracic procedures in the pregnant trauma patient. The uterus may cause the diaphragm to rise by up to 4cm and therefore, in order to reduce the risk of iatrogenic injury to vital organs or the elevated diaphragm, the site of thoracostomy should be higher than the classical 5th intercostal space (McAuley, 2004 & Einav, 2013) [IV].

Circulation

1. *A recommendation is given for limited reliance to be placed on blood pressure as a marker of hypovolaemia following trauma.[D]*

   Due to the limited amount of literature for the physiological strain of trauma upon the variant physiology in pregnancy, elements of physiological response to exercise may offer a parallel for extrapolation of effects. Heart rate is the primary physiological marker to change, rising during pregnancy by 8 – 16 beats/min (Clapp, 1985 & Hunter, 1992). The effect may be less evident in supine or lateral positions and more evident during sitting (Ueland, 1969). Notable increase in blood volume also occurs, rising approximately 1500 mL, (Pritchard, 1965) of which 1000 mL is plasma volume and 500 mL is erythrocytes (Cunningham, 2005 & Yeomans, 2005). With plasma volume amplified more than red blood cell volume, up to 45% over pre-gravid levels, the resultant hypervolaemic state is often referred to as 'physiological anaemia of pregnancy' (Wadlington, 1998). Blood volume expansion may be even greater in multifetal gestations (Yeomans, 2005). The effect of this dilution means that the fluid volume in pregnancy increases to 100ml/kg. This may be considered to be a protective factor for mother and fetus during periods of haemorrhage, traumatic or obstetric. However, the pregnant trauma patient may lose up to 35% circulating blood volume prior to exhibiting signs or symptoms of hypovolaemic shock. Blood pressure is not increased in normal pregnancy, due to decreased peripheral vascular resistance (Wadlington, 1998). Both the systolic and diastolic blood pressures decrease until 24 weeks gestation, with gradual recovery to pre-pregnancy levels by the latter stages of gestation (MacGillivray, 1969). Systolic pressure may remain stable, whereas diastolic pressure decreases up to 15 mmHg in mid-pregnancy (Ezmerli, 2000). Pregnancy maximally dilates the uterine vasculature, so that auto-regulation is compromised, and uterine blood flow is directly dependent on maternal mean arterial pressure (Chulu, 2003). Measurement of the brachial arterial pressure may not give a true indication of uterine arterial pressure and the uterine arterial pressure can be extremely low, even when the brachial arterial pressure is normal. The uterine blood flow increases from approximately 50mL/min pre-pregnancy to 500mL/min at 40 weeks gestation. The corresponding change of systemic cardiac output is from 2% to 18% during the third trimester (Bieniarz, 1966, 1969). The combination of the increased heart rate, circulating volume and the lower vascular resistance of the uterus

and placenta, leads to an increase in resting cardiac output, approximately 25% greater than pre-gravid levels (Metcalfe, 1981).

2. *Examination of the uterus and external genitalia is recommended to complete abdominal evaluation for haemorrhage. [D]*

   The principle obstetric complication of concern to the pre-hospital practitioner when encountering a pregnant trauma patient is antepartum haemorrhage. Defined as bleeding in pregnancy after 24 weeks gestation, antepartum haemorrhage has an incidence of 3-5% in pregnancy. Classification is based upon blood loss; Minor (>50ml), Major (50-1000ml), Massive (>1000ml), Torrential (Uncontrollable or Life-Threatening). Visual estimation of blood loss however is often inaccurate and additional factors should be considered in definition of major antepartum haemorrhage. These include a change in Haemoglobin (Hb) greater than 4g/dl or the requirement for a red blood cell transfusion of greater than 4 units. However, the ability to make a judgement to the severity of antepartum haemorrhage in the pre-hospital setting is extremely limited. Thus, any bleeding in the presence of trauma injury should be suspected as being significant and be factored into clinical decision making regarding acute management and transfer destination.

   Unfortunately, the progression of severity of antepartum haemorrhage and the potential for torrential haemorrhage is ever present. The complications of which can include intra-uterine death/fetal demise, disseminated intravascular coagulopathy & maternal mortality. The commonest causes for traumatic antepartum haemorrhage are placental abruption and uterine rupture. Placental abruption is the separation of the placental vasculature from the uterine wall. Uterine rupture is the term for any breach in the myometrial wall of the uterus and can be potentially catastrophic. Antepartum haemorrhage can be either concealed or revealed. Concealed antepartum haemorrhage occurs in 20-35% of cases (Ngeh, 2006). There is potential for a concealed haemorrhage to be major. Principle clinical features suggestive of uterine injury include; abdominal pain, tenderness on abdominal palpation, rigidity of the uterus, absence of fetal heart rate on auscultation and evidence of injury to the external genitalia. Failure to examine the uterus can lead potentially missing a source of significant injury and is recommended as part of thorough evaluation.

3. *Manual Uterine Displacement or Left Lateral Tilt Positioning is recommended at all times for the pregnant trauma patient.[D]*

   The positioning of the pregnant trauma patient has significant implications for the anatomy, physiology and treatment. A clarification of positioning, including definition of terminology is provided below.

   a. Supine: In the supine position, lying flat on her back, the pregnant woman's uterus will apply extrinsic compression of the inferior vena cava (IVC) (Kerr, 1964) and laterally displaces the subrenal aorta (Bieniarz, 1968). Compression of the IVC reduces maternal cardiac output (Vorys , 1961; Lees, 1967; Clark, 1991 & Danilenko-Dixon, 1996) and can result in patients developing supine hypotension syndrome (SHS), compromising circulation. Aortocaval compression is often concealed, with only 10% of pregnant women exhibiting

supine hypotension syndrome (Howard, 1953 & Holmes, 1960). Usually SHS is encountered in late pregnancy, however it may be seen from the 20th week of gestation and in the post-partum period (Kinsella, 1994).

b. Tilt: In order to avoid or reduce the uterine compression of the IVC and resulting propensity for SHS, whilst maintaining an inline spinal immobilisation position, the patient can be tilted to the right or the left side. The angle and direction of tilt has an important effect on compression of the IVC. The IVC, along with the abdominal aorta, run in the midline of the retroperitoneal space. The IVC is right of the midline and the aorta is to the left. Therefore, a benefit is achieved from left tilt (or right side up) to offload the IVC. The angle of tilt is vital, with the required uterine displacement only achieved by a minimum of 15º tilt (Crawford, 1972). Tilt less than 15º is not associated with a reduction in aortocaval compression (Bamber, 2003 & Lee, 2012). Right tilt (or left side up) less than 15º is associated with decreased cardiac output as a result of aortocaval compression (Bamber, 2003).
c. Lateral: The lateral position is the rotation of the patient by 90º, either to the right or the left dependent upon clinical findings or needs. Lateral positioning in either direction avoids uterine compression of the IVC. Inline spinal immobilisation can be preserved in the lateral position, however requires a sufficient number of personnel to maintain in a safe fashion.
d. Recovery: The standard recovery position is also sufficient to avoid uterine compression of the IVC. Yet this slumped position proves difficult to maintain spinal immobilisation and should be used when maintaining the airway takes clinical priority or spinal injury is not suspected.

Manual Uterine Displacement is the term given for the act of physical shifting of the uterus from the midline position as an alternative method of alleviating uterine compression of the IVC. It requires a technique of "up, off and over", in order to displace the uterus.

The consensus group makes recognition of the fact that in the majority of ambulances across the United Kingdom, positioning of pregnant trauma patient in left lateral tilt would result in the patient facing the sidewall of the vehicle. Manual uterine displacement would be the alternative, should the patient not tolerate tilting or require intervention.

4. *Recommendation is given to aim for the establishment of vascular access above diaphragm in the pregnant trauma patient.[D]*

The standard protocol for trauma patients should be to establish dual site intravenous (IV) access with large bore cannulas (American College of Surgeons, 2008). The consensus group recognises the potential for sub-diaphragmatic vascular access to be compromised by uterine compression of the IVC. Intraosseous (IO) access is useful alternative to gain vascular access and is recommended as a rescue measure when IV access cannot be established easily or promptly (Leidel, 2012) [III]. The site of IO access should note extremity injuries and attempt to avoid suspected fracture sites or be outside zones of injury where possible. The primary site of IO access to be placed above the diaphragm to minimise the risk of access compromise from uterine

compression of the IVC. If appropriate, IO access should be placed to the right humeral head, in order to facilitate left tilt / left lateral positioning of the patient.

5. *A recommendation is given for the early administration of blood products in the aggressive volume resuscitation of the pregnant trauma patient.[C]*
   Due to the physiological changes in pregnancy, administration of non-blood products for volume resuscitation further increases the physiological anaemia of pregnancy. Infusion of sufficient fluid volumes to maintain life, titrated against a palpable radial pulse to determine the requirement for fluid administration. The avoidance of large volume crystalloid or colloid infusion is further advocated. The activation of a Massive Transfusion Protocol for the pregnant trauma patient with in suspected haemorrhage is advisable (Riskin, 2009) [II]. Recent advances in resuscitation principles in both trauma and obstetric haemorrhage indicate survival improvements from the use of early blood resuscitation (Saad, 2014) [III].
6. *A strong recommendation is made for the use of Tranexamic Acid (TXA), as per Standard Operating Procedures (SOP) in trauma patients, for pregnant trauma patients.[B]*
   Tranexamic acid has been demonstrated to confer improved survival benefits when administered to bleeding trauma patients (Roberts, 2011) [I/II]. Early administration, within in 3 hours of injury, is required in order to maximise benefits and avoid potential harm, therefore pre-hospital services play a crucial role in its administration. Further evidence has also demonstrated TXA has effective use in obstetric haemorrhage, without adverse maternal or fetal outcomes (McClure, 2014 & Plaat, 2014) [IV].
7. *A strong recommendation is made for the use of pelvic binder devices, as per SOPs in trauma, for pregnant trauma patients.[C]*
   Further guidance can be found on the pre-hospital management of pelvic injuries in "The pre-hospital management of pelvic fractures: initial consensus statement" (Scott, 2014) [III]. Due to the range of available devices, and associated effectiveness, without sufficient scientific evidential support no specific device is recommended.

Disability

1. *Spinal immobilisation precautions are recommended as per SOPs for pregnant trauma patients.[D]*
   Injury to the spine or spinal cord is comparable for pregnant and non-pregnant trauma patients alike. Although limited literature exists defining the relative risk of spinal injury for pregnant patients, evaluation of registry information has not demonstrated difference in incidence [IV]. Cervical spine immobilisation with a cervical collar should confer benefits which outweigh any potential risks. The anatomical changes common in pregnancy may exacerbate risk of complication from cervical collars and should be given careful consideration. If a collar is not applied, pregnant trauma patients should have manual inline stabilisation maintained and minimal patient handling measures used. Further guidance regarding pre-hospital minimal patient

handling can be found in “Minimal patient handling: a faculty of pre-hospital care consensus statement” (Moss, 2013) [III].

2. *The placement of adjuncts to achieve sufficient patient tilt should be positioned below any spinal immobilisation devices and be supported along the length of any devices.[D]*
   In order to achieve a sufficient patient tilt to alleviate SHS any wedge or alternative should be placed below any spinal immobilisation devices wherever possible. Also, the wedge should support the length of the spinal immobilisation device, in order to be a stable platform and prevent hinging under the weight of the patient. The consensus group undertook practical demonstration of method and unanimously agreed on its recommendation, in the absence of evidence from literature [IV].

Resuscitation

1. *A strong recommendation is made that Cardiopulmonary Resuscitation (CPR) must be performed in a supine position with manual uterine displacement.[B]*
   Patient positioning arises again when considering the clinical effectiveness of cardiopulmonary resuscitation. External chest compressions generate approximately 30% cardiac output when performed correctly, however the levels of cardiac output decrease markedly if attempted in sub-optimal positions. Tilting, with a wedge/firm support acting as a splintage for the chest results in only 80% compression force achieved compared with the supine position (Rees, 1988), this is even further reduced if attempted in the lateral position (Jeejeebhoy, 2011) [II].
2. *A recommendation is given for Resuscitative Hysterotomy to be completed as soon as possible following the onset of maternal cardiac arrest and within 15 minutes following witnessed cardiac arrest with ongoing CPR. [D]*
   Resuscitative Hysterotomy (RH) is the preferred term for the procedure over Peri-Mortem Caesarean Section, in order to distinguish between that which is performed in the interest of maternal survival and that which is performed to save the baby. Physiological changes of pregnancy, in relation to uterine blood flow, mean the percentage of cardiac output (CO) increases from 2% in the non-pregnant state to 18% during the third trimester (Bieniarz, 1966, 1969). Emptying of the uterus following normal delivery results in a 60–80% increase in CO, but following caesarean section this is closer to a 30% increase in cardiac output. Nonetheless this increase in CO increases the likelihood of maternal survival (Hill, 2008) [IV]. Further guidance regarding resuscitative hysterotomy may be found in the companion article.

Communication / Voice Procedure

1. *A recommendation is given for the modification of the hand over / interpersonal communication of health care professionals when managing pregnant trauma patients below. (Example Use: AT-MIST with modification in pregnancy)*
   a. *Age; <u>Maternal age and estimated gestation.</u>*

b. *Time of Injury.*
c. *Mechanism.*
d. *Injuries Suspected – Potential Obstetric Complication.*
e. *Signs & Symptoms – Obstetric Clinical Findings.*
f. *Treatment – Requirement for Obstetrics, Paediatrics/Neonatology. [D]*

In order to aid the passage of relevant information in a timely fashion, the use of a structured handover system, which highlights aspects of patient characteristics. Although the impact of such details may have on the overall outcome for the patient is difficult to quantify, thus limited study has been conducted into this area, and the consensus group advocates the use [IV].

Transportation & Services

1. *A strong recommendation is made that all pregnant trauma patients should be assessed primarily within the Emergency Department of the receiving facility and obstetric/paediatric/neonatal services should attend as clinically indicated. [D]*
   The consensus group unanimously agreed to the necessity for emergency care of trauma patients to take place within the Emergency Department of the receiving hospital. The ability to provide adequate trauma resuscitation and intervention may be compromised by delivering a pregnant trauma patient to maternity units. Early notification of the receiving facility to alert the on call obstetrician to assist in the resuscitation of the pregnant trauma patient is advisable [IV].
2. *A recommendation is given for "D15 standard contract for Major Trauma Centres" to include and be mandatory for the provision of "on site or co-located" obstetric services.[D]*
   Currently, the commissioning requirements for the designation of a major trauma centre do not include provision of on site, co-located or independent obstetric services. The consensus group advocates the care of pregnant trauma patients to be performed as part of a multi-specialty combined care model, for which obstetric services are mandatory [IV].
3. *A strong recommendation is given for the adoption of a sophisticated triage tool or review system to operate within all regional trauma networks.[C]*
   Recent literature has provided additional support for advocating the use of sophisticated triage tools by the pre-hospital services to guide destination of trauma patients to provide optimal treatment for their injuries. Higher levels of evidence are available from North American literature demonstrating the sensitivity and specificity of the national trauma triage tool (Newgard, 2011) [III]. Limited evidence is available from the United Kingdom and currently no national standards exist.
4. *A recommendation for the adaptation of UK Trauma Triage Tools, when considering pregnant trauma patients is summarised below:*
   a. *Pregnancy <20 weeks; follow normal triage tool pathway.*
   b. *Pregnancy > 20 weeks, otherwise trauma triage negative; attend nearest trauma unit with obstetric services.*

c. *Pregnancy > 20 weeks, trauma triage positive; attend nearest Major Trauma Centre with available Obstetric Services.[B]*

Evidence suggests that pregnancy is not shown to be an independent predictor for the need for major trauma activation (Greene, 2007 & Aufforth, 2010) [IIb]. Although, pregnancy alone should not be sole activation trigger for major trauma, all pregnant patients involved in trauma require competent assessment of the status of the pregnancy and adequate monitoring, to exclude maternal and fetal injury.

Limitations

This guideline is based on the best available evidence concerning pre-hospital obstetric and trauma care. However, a guideline can never be a substitute for clinical judgement and there may be cases where it is appropriate for clinicians to be guided according to the needs of individual patients. Furthermore, the responsibility for the care of individual patients rests with the clinician in charge of the patient's care and the advice offered in this guideline must, of necessity, be of a general nature and should not be relied upon as the only source of advice in the treatment of patients. Literature is limited, with very few high level articles available, not requiring extrapolation or inference of conclusions/outcomes.

Further Research

The recommendations provided in this consensus statement are based upon the available clinical literature, as well as the input from a wide range of experienced clinicians. Principle aspects requiring further investigation include; robust epidemiological evaluation of the incidence of pregnancy in major trauma in the United Kingdom, the adequacy of tilt angle required to alleviate uterine compression of the IVC or to avoid SHS, comparison of tilt against manual uterine displacement in pregnancy. General aspects of pre-hospital trauma care, not limited to pregnancy, have been highlighted as part of this investigation, but are beyond the scope of this particular article at present.

Summary

This consensus statement seeks to provide clear guidance for the management of pregnant trauma patients in the pre-hospital setting. Pregnant trauma patients have certain clinical management priorities beyond that of the non-pregnant trauma patients and if overlooked may be detrimental to maternal and fetal outcomes.

Contributors

The literature search was produced by EB. The consensus programme presentations were given by JC, CC, FP, NA, NC, MW, RM, CB, MR, CL, JR, MN & EB. The delivery of the consensus process was co-ordinated by Professor KP.

Funding

Faculty of Pre-Hospital Care

Provenance & Peer Review

Commissioned; Internally Peer Reviewed

Citation

References

American College of Surgeons Committee on Trauma. Advanced Trauma Life Support for Doctors, Student Manual. Chicago: First Impressions; 2008.

Aufforth, R., Edhayan, E., & Dempah, D. (2010). Should pregnancy be a sole criterion for trauma code activation: a review of the trauma registry. The American Journal of Surgery, 199(3), 387-390.

Bamber, J. H., & Dresner, M. (2003). Aortocaval compression in pregnancy: the effect of changing the degree and direction of lateral tilt on maternal cardiac output. Anesthesia & Analgesia, 97(1), 256-258.

Barraco, R. D., Chiu, W. C., Clancy, T. V., Como, J. J., Ebert, J. B., Hess, L. W., ... & Weiss, P. M. (2005). Practice management guidelines for the diagnosis and management of injury in the pregnant patient: the EAST practice management guidelines work group. East Assoc Surg Trauma.

Barraco, R. D., Chiu, W. C., Clancy, T. V., Como, J. J., Ebert, J. B., Hess, L. W., ... & Weiss, P. M. (2010). Practice management guidelines for the diagnosis and management of injury in the pregnant patient: the EAST Practice Management Guidelines Work Group. Journal of Trauma-Injury, Infection, and Critical Care, 69(1), 211-214.

Battaloglu, E., Battaloglu, E. E., Chu, J., & Porter, K. (2015). Obstetrics in trauma. Trauma, 17(1), 17-23.

Bieniarz J, Maqueda E and Caldeyro-Barcia R. Compression of aorta by the uterus in late human pregnancy. Variations between femoral and brachial artery pressure with changes from hypertension to hypotension. Am J Obstet Gynecol 1966; 95(6): 795–808.

Bieniarz, J., Yoshida, T., Romero-Salinas, G., Curuchet, E., Caldeyro-Barcia, R., & Crottogini, J. J. (1969). Aortocaval compression by the uterus in late human pregnancy. IV. Circulatory homeostasis by preferential perfusion of the placenta. American journal of obstetrics and gynecology, 103(1), 19.

Bieniarz J, Crottogini JJ, Curuchet E, et al. Aortocaval compression by the uterus in late human pregnancy: an arteriographic study. Am J Obstet Gynecol 1968;100:203–17

Chang FC, Harrison PB, Beech RR, Helmer SD. PASG: does it help in the management of traumatic shock? J Trauma 1995;39:453–6

Chang, L. Y., & Tsen, L. C. (2013). The development and historical context of the datta short laryngoscope handle. Anesthesia & Analgesia, 117(6), 1480-1484.

Chesnutt, A. N. (2004). Physiology of normal pregnancy. Critical care clinics,20(4), 609-615.

Chulu A and Kuczkowski KM. Anaesthetic management of the parturient with massive peripartum haemorrhage and fetal demise. Anaesthesia 2003; 58(9): 933–934.

Clapp III, J. F. (1985). Maternal heart rate in pregnancy. American journal of obstetrics and gynecology, 152(6), 659-660.

Clark SL, Cotton DB, Pivarnik JM, et al. Position change and central hemodynamic profile during normal third-trimester pregnancy and post-partum. Am J Obstet Gynecol 1991;164: 883–7.

Cook, T., & Howes, B. (2011). Supraglottic airway devices: recent advances. Continuing Education in Anaesthesia, Critical Care & Pain, 11(2), 56-61.

Cook, T. M., Woodall, N., & Frerk, C. O. (2011). Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. British Journal of Anaesthesia, 106(5), 617-631.

Cook, T. M., Woodall, N., & Frerk, C. O. (2011). Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. Br J Anaesth 2011;106:632-642.

Crawford JS, Burton M, Davies P Time and lateral tilt at Caesarean section. Br J Anaesth 1972;44:477-484.

Crosby WM, Snyder RG, Snow CC, Hanson PG. (1968). Impact Injuries in Pregnancy: Experimental Studies. I. Department of Transportation, Federal Aviation Administration, Office of Aviation Medicine.

Cunningham FG, Gant NF, Leveno KJ, et al. Williams obstetrics. New York: McGraw-Hill, 2005

Danilenko-Dixon DR, Tefft L, Cohen RA, et al. Positional effects on maternal cardiac output during labor with epidural analgesia. Am J Obstet Gynecol 1996;175:867–72.

Ezmerli NM. Exercise in pregnancy. Prim Care Update Ob Gyns 2000; 7: 260-5)

Einav, S., Kaufman, N., & Sela, H. Y. (2012). Maternal cardiac arrest and perimortem caesarean delivery: evidence or expert-based?. Resuscitation, 83(10), 1191-1200.

Gatti, F., Spagnoli, M., Zerbi, S. M., Colombo, D., Landriscina, M., & Kette, F. (2014). Out-of-Hospital Perimortem Cesarean Section as Resuscitative Hysterotomy in Maternal Posttraumatic Cardiac Arrest. Case Reports in Emergency Medicine, 2014.

Grady K, Howell C, Cox C, editors. The MOET course manual: managing obstetric emergencies and trauma. 2nd ed. London: RCOG press; 2007.

Greene, W., Robinson, L., Rizzo, A. G., Sakran, J., Hendershot, K., Moore, A., ... & Fakhry, S. M. (2007). Pregnancy is not a sufficient indicator for trauma team activation. Journal of Trauma and Acute Care Surgery, 63(3), 550-555.

Hill, C. C., & Pickinpaugh, J. (2008). Trauma and surgical emergencies in the obstetric patient. Surgical Clinics of North America, 88(2), 421-440.

Hocking, G., Roberts, F. L., & Thew, M. E. (2001). Airway obstruction with cricoid pressure and lateral tilt. Anaesthesia, 56(9), 825-828.

Holmes F. Incidence of the supine hypotensive syndrome in late pregnancy: a clinical study in 500 subjects. J Obstet Gynaecol Br Emp 1960;67:254–8

Howard BK, Goodsen JH, Mengert MD. Supine hypotension syndrome in late pregnancy. Obstet Gynecol 1953;1:371–7.

Hunter, S., & Robson, S. C. (1992). Adaptation of the maternal heart in pregnancy. British heart journal, 68(6), 540.

Jeejeebhoy, F. M., Zelop, C. M., Windrim, R., Carvalho, J. C., Dorian, P., & Morrison, L. J. (2011). Management of cardiac arrest in pregnancy: a systematic review. Resuscitation, 82(7), 801-809.)

Jones R, Baird SM, Thurman S, Gaskin IM. Maternal cardiac arrest: an overview. Journal of Perinatal and Neonatal Nursing. 2012; 26(2):117-123.

Kerr MG, Scott DB, Samuel E. Studies of the inferior vena cava in late pregnancy. Br Med J 1964;1:532–3.

Kinsella, M. S., & Lohmann, G. (1994). Supine hypotensive syndrome. Obstetrics & Gynecology, 83(5), 774-788.

Kleinman, M. E., Chameides, L., Schexnayder, S. M., Samson, R. A., Hazinski, M. F., Atkins, D. L., & Zaritsky, A. L. (2010). Pediatric advanced life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Pediatrics, 126(5), e1361-e1399.

Kuo C, Jamieson DJ, McPheeters ML, et al. Injury hospitalizations of pregnant women in the United States, 2002. Am J Obstet Gynecol 2007; 196(2): 161–e1.

Lavin JP, Polsky SS. (1983). Abdominal trauma during pregnancy. Clin Perinatol.; 10:423-438

Lee, S. W. Y., Khaw, K. S., Kee, W. N., Leung, T. Y., & Critchley, L. A. H. (2012). Haemodynamic effects from aortocaval compression at different angles of lateral tilt in non-labouring term pregnant women. British journal of anaesthesia, 109(6), 950-956.

Lees MM, Scott DB, Kerr MG, Taylor SH. The circulatory effects of recumbent postural change in late pregnancy. Clin Sci 1967; 32:453–65.

Leidel, B. A., Kirchhoff, C., Bogner, V., Braunstein, V., Biberthaler, P., & Kanz, K. G. (2012). Comparison of intraosseous versus central venous vascular access in adults under resuscitation in the emergency department with inaccessible peripheral veins. Resuscitation, 83(1), 40-45.

Lockey, D. J., Avery, P., Harris, T., Davies, G. E., & Lossius, H. M. (2013). A prospective study of physician pre-hospital anaesthesia in trauma patients: oesophageal intubation, gross airway contamination and the'quick look'airway assessment. BMC anesthesiology, 13(1), 21.

MacGillivray I, Rose GA and Rowe B. Blood pressure survey in pregnancy. Clin Sci 1969; 37(2): 395–407.

MacIntyre, A., Markarian, M. K., Carrison, D., Coates, J., Kuhls, D., & Fildes, J. J. (2007). Three-step emergency cricothyroidotomy. Military medicine,172(12), 1228-1230.

McCaul, C. L., Harney, D., Ryan, M., Moran, C., Kavanagh, B. P., & Boylan, J. F. (2005). Airway management in the lateral position: a randomized controlled trial. Anesthesia & Analgesia, 101(4), 1221-1225.

McClure, E. M., Jones, B., Rouse, D. J., Griffin, J. B., Kamath-Rayne, B. D., Downs, A., & Goldenberg, R. L. (2014). Tranexamic acid to reduce postpartum hemorrhage: a MANDATE systematic review and analyses of impact on maternal mortality. American journal of perinatology, (EFirst).

Mendez-Figueroa H, Dahlke JD, Vrees RA, et al. Trauma in pregnancy: an updated systematic review. Am J Obstet Gynecol 2013; 209(1): 1–10.

Metcalfe J, McAnulty JH and Ueland K. Cardiovascular physiology. Clin Obstet Gynecol 1981; 24(3): 693–710.

Mighty H. (1994). Trauma in pregnancy. Critical care clinics, 10(3), 623.

Morris, S., & Stacey, M. (2003). ABC of resuscitation: resuscitation in pregnancy. BMJ: British Medical Journal, 327(7426), 1277.

Nesterenko, T. H., Acun, C., Mohamed, M. A., Mohamed, A. N., Karcher, D., Larsen, J., & Aly, H. (2012). Is it a safe practice to administer oxygen during uncomplicated delivery: A randomized controlled trial? Early human development, 88(8), 677-681.

Ngeh, N., & Bhide, A. (2006). Antepartum haemorrhage. Current Obstetrics & Gynaecology, 16(2), 79-83.

Paix, B. R., & Griggs, W. M. (2012). Emergency surgical cricothyroidotomy: 24 successful cases leading to a simple 'scalpel–finger–tube'method. Emergency Medicine Australasia, 24(1), 23-30.

Petrone, P., Talving, P., Browder, T., Teixeira, P. G., Fisher, O., Lozornio, A., & Chan, L. S. (2011). Abdominal injuries in pregnancy: a 155-month study at two level 1 trauma centers. Injury, 42(1), 47-49.

Plaat, F., & Shonfeld, A. (2014). Major obstetric haemorrhage. Continuing Education in Anaesthesia, Critical Care & Pain, mku049.

Pritchard JA. Changes in the blood volume during pregnancy and delivery. Anesthesiology 1965; 26: 393-9

Quinn, A. C., Milne, D., Columb, M., Gorton, H., & Knight, M. (2013). Failed tracheal intubation in obstetric anaesthesia: 2 yr national case–control study in the UK. British journal of anaesthesia, 110(1), 74-80.

Rees, G. A. D., & Willis, B. A. (1988). Resuscitation in late pregnancy.Anaesthesia, 43(5), 347-349.

Roberts, I., Shakur, H., Afolabi, A., Brohi, K., Coats, T., Dewan, Y. & CRASH-2 collaborators. (2011). The importance of early treatment with tranexamic acid in bleeding trauma patients: an exploratory analysis of the CRASH-2 randomised controlled trial. Lancet, 377(9771), 1096-101.

Saad, A., & Costantine, M. M. (2014). Obstetric Hemorrhage: Recent Advances. Clinical obstetrics and gynecology, 57(4), 791-796.

Scott, I., Porter, K., Laird, C., Greaves, I., & Bloch, M. (2014). The pre-hospital management of pelvic fractures: initial consensus statement. Journal of Paramedic Practice, 6(5), 248-252.

Shekelle, P. G., Woolf, S. H., Eccles, M., & Grimshaw, J. (1999). Clinical guidelines: developing guidelines. BMJ: British Medical Journal, 318(7183), 593.

Schiff MA, Holt VL, Daling JR. (2002). Maternal and infant outcomes after injury during pregnancy in Washington state from 1989 to 1997. J Trauma; 53:939-45.

Sperry JL, Casey BM, McIntire DD, Minei JP, Gentilello LM & Shafi S. (2006). Long-term foetal outcomes in pregnant trauma patients. The American journal of surgery, 192(6), 715-721.

Suresh MS, Latoya Mason C, Munnur U. Cardiopulmonary resuscitation and the parturient. Best Practice and Research: Clinical Obstetrics and Gynaecology. 2010; 24(3):383-400.

Thongrong, C., Kasemsiri, P., Hofmann, J. P., Bergese, S. D., Papadimos, T. J., Gracias, V. H., ... & Stawicki, S. P. (2013). Amniotic fluid embolism. International journal of critical illness and injury science, 3(1), 51.

Timmermann, A. (2011). Supraglottic airways in difficult airway management: successes, failures, use and misuse. Anaesthesia, 66(s2), 45-56.

Ueland, K., Novy, M. J., Peterson, E. N., & Metcalfe, J. (1969). Maternal cardiovascular dynamics. IV. The influence of gestational age on the maternal cardiovascular response to posture and exercise. American journal of obstetrics and gynecology, 104(6), 856.

Vorys N, Ullery JC, Hanusek GE. The cardiac output changes in various positions in pregnancy. Am J Obstet Gynecol 1961;82: 1312–21.

Wadlington J, Natale M, Crowley M. Anesthesia for obstetrics and gynecology. In: Hurford WE, et al., editors. Clinical anesthesia procedures of the Massachusetts General Hospital. Philadelphia (PA): Lippincott Williams & Wilkins, 1998: 523-45

Whitty, J. E. (2002). Maternal cardiac arrest in pregnancy. Clinical obstetrics and gynecology, 45(2), 377-392.

Wimalasena, Y., Burns, B., Reid, C., Ware, S., & Habig, K. (2014). Apneic Oxygenation Was Associated With Decreased Desaturation Rates During Rapid Sequence Intubation by an Australian Helicopter Emergency Medicine Service.Annals of Emergency Medicine.

Yeomans ER, Gilstrap III LC. Physiologic changes in pregnancy and their impact on critical care. Crit Care Med 2005; 33: S256-8