

Trauma Service Guidelines

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Background

The Royal Melbourne Hospital (RMH) is one of Australia’s busiest major trauma services and is designated to care for obstetric trauma patients due to its colocation with The Royal Women’s hospital (RWH). In 2018, RMH admitted and cared for over 4673 trauma patients; of these, only 3% were pregnant, and 0% were classified as having severe injuries (Major Trauma).¹ However, this is a unique group that requires specific expertise to ensure good outcomes for the pregnant women and their babies.

Overall trauma occurs in 8% of all pregnancies. It is the most common cause of non-obstetric fetal and maternal mortality, and is associated with significant maternal and fetal complications. One third of women admitted to hospital following trauma deliver during admission.² The risk of injury relates to the severity of the trauma, however fetal injury can occur with no or minor maternal injury, with half of fetal deaths occurring in minor trauma.³ Fetal mortality increases with gestational age, with just over half of fetal deaths occurring in the third trimester.²⁻⁶

A pregnant woman represents two patients. The key management principle is to optimally resuscitate the mother, as doing so will maximise fetal survival. However, where possible, management decisions should also be made in the best interests of the fetus, where this does not compromise the treatment of the mother; such as the choice between two equally effective drugs with differing fetal toxicity risks.^{2, 3, 7, 8}

Specific anatomical and physiological changes occur during pregnancy that alters the body’s response to injury, and thus the pregnant patient requires a modified approach to resuscitation.^{2, 5, 8, 9} The underlying principles guiding the management of the multitrauma pregnant patient are that the initial reception and resuscitation will be conducted at RMH, providing a multidisciplinary approach including emergency physicians, anaesthetists, trauma surgeons, obstetricians, nursing and radiology input.

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If the injury to the pregnant woman is assessed as being minor and does not require admission to a general hospital for trauma care, she may be transferred (following appropriate guidelines) to the Royal Women's Hospital (RWH). This is a joint decision between the patient, the emergency physicians, admitting consultant surgeon at RMH and the obstetrician of the day from the RWH.

Importantly, all females of child-bearing age presenting following trauma must be asked if they are or could be pregnant and should have a pregnancy test as part of their secondary survey.⁸

Mechanisms of Injury

The most common mechanism of injury in obstetric trauma at RMH and internationally is motor vehicle crashes (MVCs), with 79% of all pregnant trauma patients presenting to RMH as a result of a MVC. This is followed by falls, intentional violence and self-harm.^{1, 10} Entrapment is more common in pregnancy due to the size and immobility of the mother and falls are more common in pregnancy due to an altered centre of gravity and other factors which are most common in the third trimester.^{2, 4, 5, 11}

Due to the protection of the gravid uterus, bowel injury is less common in pregnancy following blunt or penetrating trauma, however overall, pregnant women compared with non-pregnant women have a higher incidence of serious abdominal injury and a lower incidence of chest and head injury. If pelvic fracture occurs, the increased vascularity of the pelvis can lead to massive pelvic or retroperitoneal haemorrhage.¹²

Fetal injury following trauma can be direct or indirect,^{2, 4} with direct abdominal trauma causing organ ruptures, cervical and skull fractures, and intracranial haemorrhage. Indirect trauma can result in fetal demise through placental abruption, preterm labour or uterine rupture. Injuries remote to the abdomen, such as limb or intracranial injuries, can compromise the fetus through disturbance in maternal physiology.^{5, 10, 13}

Fetal Outcome Determinants

All fetal deaths at RMH in the last 10 years (2008 -18) were a direct result of MVCs, falls, assaults or penetrating injuries.¹⁴ The best predictor of fetal outcome is the injury severity of the mother. However, even relatively minor trauma can be associated with fetal injury, and fetal death can occur without any maternal injury.^{4, 5, 15}

Placental abruption is most commonly caused by MVCs, and results from the shearing forces between the placenta and uterine wall that occurs with rapid deceleration. Abruption (detectable via maternal blood testing, cardiotocograph or ultrasound changes) causes fetal anaemia, hypoperfusion and decreased oxygenation of the fetus, which can cause developmental disorders or fetal death.³ The risk of abruption is related to gestation, and occurs most commonly in gestations greater than 16 weeks.¹² RMH placental abruptions have occurred at the average 27 weeks with the range being 8-37 weeks.¹ Factors associated with abruption include maternal hypotension and hypoxia, high injury severity score, maternal pelvic fracture, young maternal age, acidosis, shock and uteroplacental or fetal injury.

Preterm labour (defined as > 20 weeks) can result from direct uterine impact or from disturbance in maternal physiology, such as maternal bleeding or hypoxia, and its outcome is largely dependent on gestational age, with the risk increasing with gestation.³

Uterine rupture is rare, occurring in 0.6% of traumas, but when it occurs it is associated with 10% maternal mortality and nearly 100% fetal mortality. The most common cause of rupture is blunt abdominal trauma, and usually in the second and third trimesters.⁵

Seatbelt use is a predictor of maternal and fetal outcome. Unrestrained pregnant patients are two times more likely to have maternal haemorrhage, are at significantly higher risk of dying, and are nearly three times more likely to have fetal death. The seatbelt both decreases uterine strain and the pressure on the uterus if it collides with the steering wheel. It is unclear if airbag deployment is associated with poorer outcomes, due to the difficulty in separating the risk of airbag deployment itself from the severity of crash in which airbags are deployed.^{16, 17}

Trauma Care

Identification and treatment of maternal life-threatening injuries is the first priority. The primary goal of treatment is the maintenance of uteroplacental perfusion of the mother, and fetal oxygenation by avoiding hypoxia, preventing hypotension, acidosis and hypothermia. Only when stabilised or if the mother has minor injuries should the secondary survey be performed, including assessment of fetal well-being utilising cardiotocography (CTG) monitoring and ultrasound.^{2, 4, 5, 17}

Primary Survey

The primary survey is conducted in the same manner as for a non-pregnant patient. ⁴

Airway

A patent airway remains the first priority with administration of 100% oxygen by face mask to prevent or treat hypoxaemia. Maternal hypoxia is associated with poor fetal outcomes. ^{2, 4, 18} Standard cervical spine assessment, immobilisation and management is required.

Obstetric patients have been shown to have an eight-fold increase in the rate of failed intubation, and difficulty increases in later stages of pregnancy. If the patient requires intubation, difficult airway equipment must be immediately available. Confirmation of tube placement should be with auscultation & capnography. ¹⁹

Breathing

Hypoxaemia develops more rapidly in the pregnant patient due to a limited oxygen reserve and higher metabolic requirement, therefore oxygenation requires close monitoring. Pregnant patients require a higher partial pressure of oxygen to establish the same maternal oxygen saturation. ¹⁸ A nasogastric tube should be inserted in semiconscious or unconscious women, ¹⁹ due to an increased risk of aspiration. Nasogastric tube placement in pregnancy is associated with an increased risk of epistaxis due to mucosal hyperaemia. Patients in late pregnancy should have intercostal catheters placed one or two rib spaces higher due to the patient's elevated diaphragm. ¹⁹ Ventilation should aim to achieve a normal PaO₂ and a CO₂ 27-32mmHg. ^{2, 4, 6, 20}

Circulation

Left lateral tilt (30-45 degree) using a wedge can significantly improve the systolic blood pressure and must be utilised in the care of the pregnant woman. ^{18, 19} Maintenance of circulating blood volume is critical and aggressive fluid resuscitation should be initiated if hypovolemia is suspected, to optimise the maternal cardiac output and maintain uteroplacental perfusion. ^{2, 4, 6, 20}

Intravenous (IV) access with two large bore IV cannulas should be inserted, and these should be above the diaphragm if possible so that IV therapy is not obstructed by the gravid uterus. Routine trauma bloods should be ordered including Kleihauer if Rhesus (Rh) (D) negative. ^{18, 19}

Initial resuscitation should be based on ATLS principles, ⁴ which include early and empirical administration of red blood cells and products in patients with severe shock. The use of blood products in resuscitation is significantly higher in pregnant compared to non-pregnant women. ¹¹ Caution must be taken in penetrating trauma not to 'over-resuscitate' and thereby risk interference with clot formation (which may contribute to increased blood loss, hypothermia, acidosis and coagulopathy). Fluid resuscitation should aim to normalise vital signs and urine output for the pregnant state. ^{2, 4, 6, 20}

Cardiac Arrest

If a traumatic cardiac arrest occurs, the algorithm for management, including chest compressions, defibrillation and medications, is the same as a with non-pregnant trauma patient. See [RMH TRM08.12 Trauma Cardiac Arrest Guideline](#).

However, it should be remembered that the patient should be placed supine instead of the left lateral tilt to allow quality chest compressions. Resuscitative hysterotomy (also called perimortem caesarean) section must be considered early ^{18, 21}

Resuscitative Hysterotomy or Perimortem Caesarean Section

This is a hysterotomy performed to resuscitate a woman who is having a traumatic cardiac arrest.

It should be contemplated in arresting pregnant patients not responding to resuscitation/ cardiopulmonary resuscitation (CPR) and when the fundus is above the umbilicus. CPR may be very difficult in the pregnant patient, and when combined with aortocaval compression, may be inefficient in providing enough cardiac output for organ perfusion. ^{7, 22-24} This procedure can be lifesaving for mother and her fetus if performed within 5 mins, although the primary aim of the procedure is to optimise maternal resuscitation. ^{7, 22-}

²⁴ The tolerable duration of apnoea and pulselessness for a pregnant woman is only 5 minutes, with the chances of successful resuscitation of woman or fetus decreasing after this time and no benefit beyond 30 minutes. ²²⁻²⁵

The timeframe precludes transfer to the operating theatre, and as the fetal condition has no bearing on the decision to perform a resuscitative hysterotomy, time should not be wasted attempting to confirm the presence of a fetal heartbeat. The only equipment required is a scalpel. Antiseptic solution can be poured onto the maternal abdomen if desired. Maternal CPR should be continued throughout the delivery of the fetus which may improve venous return and increase the success of CPR, thus increasing the chance of maternal survival.

Consideration must also be given to the aetiology of the cardiac arrest considering both obstetric and traumatic complications. ^{7, 22} In maternal hypovolaemic arrest, the fetus may have already suffered a prolonged period of hypoxia.

PREGNANT TRAUMA PATIENT GUIDELINE

A **Trauma Call** should be initiated for all pregnant patients ≥ 20 weeks with a traumatic mechanism and ruptured membranes, PV bleeding and/or fetal heart rate < 100 bpm.

If the prehospital information does **not meet** a **Trauma Call** and it is a known pregnant patient who is ≥ 20 weeks, a **Trauma Alert** should be activated.

Senior ED medical staff contacts the Royal Women's Hospital Senior Obstetrician Registrar on for Birth Centre of the day as soon as notification of an arrival for the pregnant patient presenting as a trauma call or alert.

IN TIME CRITICAL/ EMERGENCY CASES call RWH emergency number: 0 8345 2222

Request to speak to the senior obstetric registrar on birth centre

Alternatively in NON-TIME CRITICAL CASES

RWH telephone: dial 0 8345 2000

[when not an emergency & press 4 immediately to be put through to an operator,
do not need to wait for instructions]

Request to speak to the senior obstetric registrar on birth centre

If the patient **requires immediate** laparotomy/ caesarean or other urgent trauma surgery, this should **always** be conducted at RMH, with an obstetrician in attendance, and the availability of a neonatal team to care for the infant.

If immediate caesarean section is required THE NEONATAL RESPONSE TEAM should be contacted.

Team includes: Neonatal Consultant/ Fellow/ Resident and Neonatal Admission Nurse)

call RWH emergency number: 0 8345 2222; Neonatal fellow (24/7) page 53313

If delivery is NOT urgent, the Obstetrician involved in the case will inform the RWH team of the necessary details.

If no response from the registrar escalate to the obstetric consultant of the day via RWH switch board (0 8345 2000 press 4 immediately or 0 8345 2222 in case of emergency)

*Pink Alert Procedure is an emergency response for both internal emergencies at RWH and externally for those at RMH. The procedure is for urgent obstetric assistance for an obstetric emergency. ²⁶

RMH staff phone RWH switch 0 8345 2222 and state "pink alert and the location" switchboard at RWH will page the most senior obstetric doctor rostered for the birth centre from 08.00-17.00.

Out of hours will page the senior registrar via the public address system stating Dr.... please go to RMH location immediate, also a lanpage will be sent with the details to their pager, the consultant on call will also be contacted via switch and requests to attend RMH. ²⁶

Switch will also contact the Birth Centre (BC) Midwife in Charge and advise them of a Pink Alert at RMH with location. Midwife in Charge of BC will allocate a midwife from the BC to attend Pink Alert at RMH.

Secondary Survey

The secondary survey is commenced once the life-threatening injuries are identified and treated. The process is the same as for the non-pregnant patient and includes a complete history, head to toe assessment, with the addition of an obstetric and fetal assessment. Complications of pregnancy can occur with little or no signs of injury.^{8,27} A pregnancy test should be included in the secondary survey for all females of child-bearing age.

Extended focused assessment with sonography in trauma (eFAST)

B-mode ultrasound is safe in the pregnant patient without adverse effects on the fetus. The diagnostic yield of FAST becomes increasingly limited with advancing gestational age. Evaluations in the first trimester are associated with high sensitivity (90%) and specificity (89%), however sensitivity drops to <50% in the second and third trimesters, whilst retaining specificity.²

Blood tests

Due to the increased risk of coagulopathies and the importance of knowing Rhesus status pregnant women must have a coagulation profile and blood group ordered,

A Kleihauer test (Flow cytometry percent fetal blood" when ordered in EPIC) may be indicated, see section below.^{19,28}

Investigation and Intervention Decisions

Patients fall into four groups:

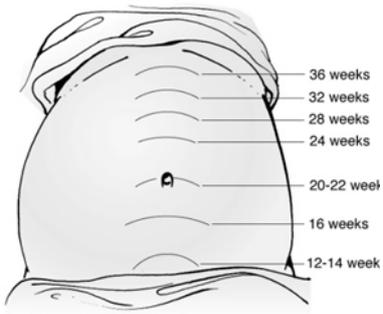
- Negative eFAST, minor injuries, and no fetal distress:** require 4 hours of CTG monitoring before being discharged. Those discharged home should be given specific instructions regarding preterm labour, bleeding and abdominal pain. Patients may be transferred RWH for ongoing care after consultation.
- Negative eFAST and complex injuries** require admission to RMH, CTG monitoring for at least 4 hours, and obstetrician review before ceasing monitoring.
- Positive eFAST but no peritoneal signs** and who are **haemodynamically stable** should proceed to abdominal CT scan to assist in determining the need for laparotomy (unless a laparotomy is indicated for caesarean section on fetal grounds).
- Positive eFAST and peritoneal signs** or who are **haemodynamically unstable** require urgent laparotomy (Trauma OPSTAT).

Obstetric Examination

Obtaining an early history is important in identifying any comorbidity that may alter patient management and includes:

- ◆ Estimated delivery date (EDD) based on early pregnancy ultrasound
- ◆ Date of last menstrual period if ultrasound EDD is not known or not performed
- ◆ Prior pregnancy complications and current pregnancy complications (including presence of fetal movements or contractions)

Gestational age can be estimated by measuring the vertical distance in the midline from the symphysis pubis to the top of the fundus (in cm). This measurement should correlate roughly with gestational age. A potentially viable or resuscitable fetus at the Royal Women's Hospital is defined as > 23 weeks gestation. Neonatal staff will always be involved and consulted regarding decisions around the possibility of resuscitation at these very early gestations. Where possible and when time permits parents are involved in this difficult decision making at peri-viability. Interpretable continuous cardiotocograph monitoring may only be possible above 26 weeks. Only a potentially viable fetus requires continuous monitoring.^{3,6,8}

Gestation age in weeks	Location of the uterus	
12-14	Just above the pubis	
16	Halfway between pubis & umbilicus	
20-22	At umbilicus	
28	Halfway between umbilicus & xyphoid	
32	3/4 of the way between umbilicus & xyphoid	
36-40	Near xyphoid	

Abdominal Assessment looking specifically for:

- ◆ Abdominal tenderness and pain
- ◆ Uterine tone – a firm, hard uterus is indicative of placental abruption
- ◆ Uterine contractions
- ◆ Uterine tenderness

Fetal presentation/orientation/lie

If a pelvic exam (usually a speculum rather than digital in the first instance) is required this should be conducted by an experienced doctor or obstetrician, looking for: ^{2, 3, 6, 8, 18}

- ◆ Vaginal bleeding – in the 2nd and 3rd trimester this is associated with placental abruption, preterm labour and placenta previa
- ◆ If in labour, cervical effacement & dilation
- ◆ Amniotic fluid – indicates ruptured membranes
- ◆ Tests such as amniure

Repeated examinations should be avoided.

NOTE: Placental abruption can occur without any maternal symptoms or signs

Fetal Assessment and Cardiotocography (CTG) Monitoring

Fetal assessment is performed for viable pregnancies >23 weeks gestation.⁶ Fetal assessment by CTG may be difficult in > 23 to 26 weeks as interpretation is difficult and ultrasound assessment may be a better determinant of fetal wellbeing at these gestations.^{29, 30}

CTG monitors fetal heart rate and uterine activity, and should be implemented as part of the secondary survey for viable fetus. Normal fetal heart rate ranges from 110 to 160 bpm, with the average being 140 bpm, with a general decline towards the lower ranges of normal closer to term. Through monitoring fetal heart rate and uterine activity, CTG can detect signs of fetal compromise.^{25, 29, 30}

Variation in fetal heart rate, called CTG variability, is a normal sign of fetal wellbeing as it is an indirect measure of fetal oxygenation. Therefore **absence of variability** may be an indication of fetal compromise as is the presence of a **decelerating fetal heart rate**.

Increased uterine activity on CTG suggests premature labour or abruption.

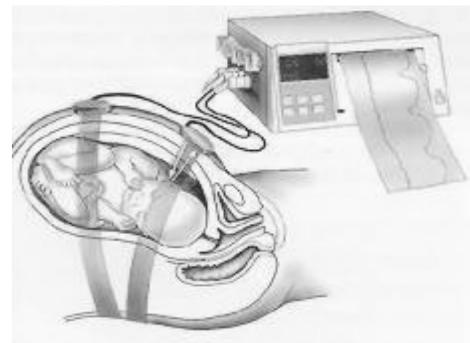
However, the most common problem caused by trauma is uterine contractions due to a release of prostaglandins secondary to placental trauma. Occasional contractions are normal and not associated with adverse outcomes in 90% of cases. Eight contractions or more an hour, over more than four hours is associated with placental abruption and carries a fetal mortality rate of 67-75%.^{29, 30}

CTG monitoring should continue throughout the acute period including in intensive care unit and the wards as prescribed by the Obstetrician. Dependent on these orders, monitoring may be continuous for the first four hours and then intermittent. RMH does not have the appropriate staff to manage ongoing continuous CTG monitoring. Appropriate midwifery care may need to be arranged for the patient at RMH if the patient is not suitable for transfer. Appropriate CTG monitoring can be useful in reassuring parents and staff about fetal status and it informs discharge planning.

A CTG monitor is located in the Emergency Department. Interpretation will be via the obstetric team, either

1. By the attending Obstetrician/Obstetric Registrar
2. Via electronic link to the RWH labour ward – this is possible if in ED trauma bay 1 or 2 by (i) plugging the CTG into the port on the bollard, (ii) entering the information on the computer outside trauma bay 1, and (iii) informing RWH labour ward and obstetric registrar of the clinical scenario
3. Or by faxing a 30 minute CTG trace to the RWH obstetric registrar, after discussing the clinical scenario with them

Ultrasound has poor sensitivity for placental abruption and more than half of cases will be missed. It can be used to measure fetal heart rate in M-mode, and can be used to assess fetal activity. Trained operators can estimate the gestational age in the second and third trimesters using head circumference or femur length. Placental location and amniotic fluid volume can also be assessed by trained operators.⁵



General Care of the Pregnant Trauma Patient

Active patient warming is to be conducted in the following situations:

- ◆ If a major trauma patient's core temperature drops below 36.5 degrees centigrade
- ◆ In any major trauma patient with signs suggesting the possibility of significant blood loss. This includes the normotensive patient with significant tachycardia (pulse rate > 110 per minute) or who is cold and shut down peripherally
- ◆ Active warming includes all fluids being infused through warming devices and external warming devices. Other more invasive forms of active warming can be employed if necessary, including the infusion of warm fluids into peritoneal or thoracic cavities

Radiology

Treat the mother first

Initial imaging priorities in the pregnant trauma patient are the same as for the non pregnant patient

[X-Ray Imaging During Pregnancy Guideline](#)

Notify radiology of the presence of a pregnant patient requiring imaging¹⁸

- ◆ Most diagnostic radiology procedures pose no substantial risk to the mother or fetus, including plain x-ray imaging of the head, neck, chest, pelvis and extremities, and CT imaging of the head, neck and chest.
- ◆ Radiation risk is related to the fetal effective dose and to the stage of pregnancy. Risk is most significant during organogenesis (2-8 weeks after fertilisation), with very few abnormalities demonstrated beyond 7 weeks in a fetus receiving >500 millisieverts of radiation.^{18, 31}
- ◆ Interventional radiology procedures involving extended fluoroscopy and CT scan of the abdomen and pelvis may result in a significant fetal radiation dose and consequently an increased risk. Nevertheless, it is highly unlikely that the fetal effective dose from diagnostic or most interventional procedures will exceed 100 millisieverts, when nervous system abnormalities, malformations, growth retardation and fetal death are possible.^{18, 31}
- ◆ Remember that in the emergency situation the optimal resuscitation, imaging and treatment of the mother will ensure the optimal chance of fetal survival. See [X-Ray Imaging During Pregnancy Guideline](#)

Transfusion

Both fetal susceptibility to cytomegalovirus (CMV) due to an immature immune system, and the risk of Rhesus (Rh) isoimmunisation must be considered when transfusion is required for resuscitation of the mother.

Recommendations

- ◆ Irrespective of the CMV status of the mother (i.e. irrespective of whether the status is known or unknown, or whether it is negative or positive), for red cell and platelet transfusions the units should be CMV antibody negative.
- ◆ Bedside leukodepletion filter is not required, as the current platelet inventory is already pre-leukodepleted if CMV negative platelet concentrates are not available.
- ◆ Only Rh (D) negative red cells and platelets should be used for pregnant women and women of child-bearing potential (e.g. <50 years of age) who are Rh(D) negative, or whose Rh(D) status is unknown.
- ◆ A prophylactic dose of anti-D is required for Rh (D) negative females who are pregnant or of child-bearing potential who receive Rh (D) positive platelets.
- ◆ Pregnant women and females of child-bearing potential who are Kell blood group negative should receive Kell negative red cells where possible.
- ◆ Transfusion support haematological consultation is required for newborns or infants (e.g. following an emergency Caesarean Section) to ensure special transfusion requirements are met.

Fetomaternal Haemorrhage Assessment

Trauma in pregnancy is unique, even a trivial injury may provoke abruption, preterm labour and its cascade of serious complications. It may also cause fetomaternal haemorrhage (FMH), which itself is associated with an increased incidence of placental abruption and is a predictor of preterm labour.

FMH occurs in 8 to 30% of pregnant women suffering abdominal trauma. The role of detectable FMH in the absence of obstetric findings on presentation is questionable and not well reported. Unfortunately, a lack of maternal and fetal signs does not preclude the possibility of abruption.

With the advent of better monitoring equipment and practices, the role of testing for FMH by Kleihauer test (Flow cytometry percent fetal blood" when ordered in EPIC) in asymptomatic pregnant trauma patients is doubtful, other than to calculate the need for additional anti D immunoglobulin in Rh (D) negative women.^{5, 10, 25}

However anecdotally FMH testing has triggered recall and/or follow-up of a number of pregnant women which was critical to the outcome.

Anti-D Administration

Haemolytic disease of the newborn may arise if the mother develops anti-red cell antibodies against fetal red cell antigens. For this reason, mothers who are Rh(D) negative routinely require prophylactic Rh(D) immunoglobulin therapy at various times in pregnancy and after delivery.

All Rh (D) negative pregnant women should be offered anti-Rh (D) immunoglobulin prophylaxis, following trauma.

Dosage for pregnancy regardless of gestation is 625 international units (intramuscular).

N.B. For women in the second and third trimesters a Kleihauer-Betke (KB) test should be performed on the mother. This test quantitates the volume of the fetomaternal haemorrhage. The doses of anti-Rh (D) listed above are given initially, without waiting for the result of the KB. Once the KB result is available then an additional dose may be required, depending on the result. Positive KB test is defined by a fetomaternal haemorrhage volume of $\geq 3\text{ml}$.

In this setting the Kleihauer test does not need to be done urgently, as there is a 72-hour window to administer any additional dose of anti-D, depending on the Kleihauer test finding. Kleihauer blood sample should be taken with the other trauma bloods, but will only be processed during working hours; hence the result in most cases may not be available until the next day. Anti-D dosing is best done in consultation with a haematologist and obstetrician.

Hospital Admission and Obstetric Review

Hospital admission and obstetric review is mandatory in patients with vaginal bleeding, uterine irritability, abdominal pain, cramping or tenderness, reduced fetal heart sounds, and in women with leaking amniotic fluid. After immediate clinical priorities are managed, the patient's usual obstetrician and GP should be notified.

APPENDIX 1: Physiological Changes in Pregnancy

Pregnancy alters the physiology in most systems, adding to the complexity of caring for a pregnant trauma patient. ^{2, 8, 20, 25, 27}

Uterus

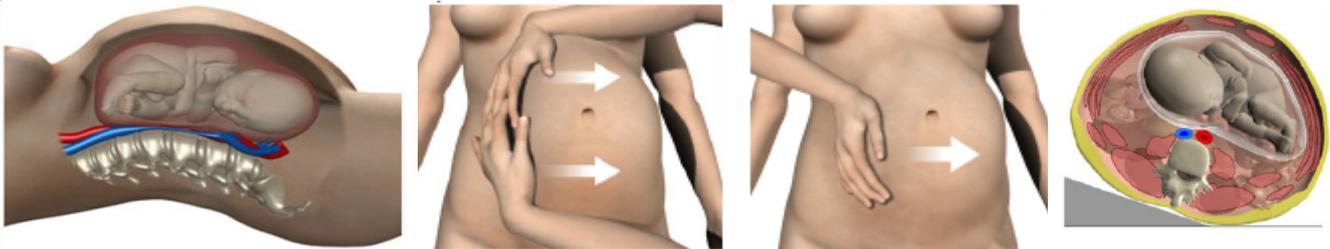
Until the 12th week of gestation, the uterus is a thick walled structure of limited size that sits within the pelvis, relatively resistant to injury. At 20 weeks, the uterus has reached the level of the umbilicus and the fetus is small and mobile, cushioned by generous amounts of amniotic fluid. By 36 weeks the uterus reaches maximal height at the costal margins and it is now a large thin walled organ with a volume of approximately 5L. During pregnancy there is a progressive increase in the uteropelvic blood flow from 60 to 600ml/min, increasing the potential for massive blood loss from the traumatised uterus or pelvis. ^{7, 32}

Cardiovascular

By the end of the 1st trimester (week 12), there is an increase in cardiac output (CO) of 1.0-1.5L/ min due to an increase in plasma volume (40 to 50%). There is also a decrease in pulmonary and peripheral resistance due to increasing progesterone levels. Systolic blood pressure will decrease by 15 to 20% with its lowest point at 28 weeks, rising again at the end of pregnancy.

Blood volume will increase by 20% during pregnancy resulting in a dilutional anaemia. The increase in cardiac output and heart rate (10-15 bpm) and decrease in resting blood pressure can mask signs of hypovolaemia. A pregnant woman may lose up to 2 litres of blood before it becomes clinically apparent in some cases. Some pregnant women in the absence of bleeding may exhibit hypotension in the supine position due to aortocaval compression (decreased venous return and CO up to 25%).

All pregnant women >20 weeks should be managed in the left lateral tilt position using a wedge under right hip and manual displacement of the uterus to reduce the effects of caval compression.



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Haematological

White blood cell count, levels of most clotting factors including fibrinogen, and plasma proteins increase in pregnancy, causing a relatively hypercoagulable state, increasing the risk of venous thromboembolism. The reference range of the APTT and INR are unaltered in pregnancy.

Placental abruption and other obstetric complications may precipitate DIC (disseminated intravascular coagulation).

Haemolytic disease of the newborn may arise if the mother develops antibodies against fetal red cell antigens. For this reason mothers who are Rh (D) negative require prophylactic Rh (D) immunoglobulin therapy at various times in pregnancy and following delivery.

Given the immaturity of the immune system of the fetus when pregnant women require blood transfusion, specialised red cell products are usually indicated (e.g. CMV negative products).

Respiratory

Many changes occur in the respiratory system of the pregnant woman with important implications. There is a 20% increase in oxygen consumption in the 3rd trimester. A 20% reduction in functional residual capacity can lead to a VQ mismatch and decrease oxygen reserves in the compromised patient. These changes predispose the pregnant patient to rapid oxygen desaturation.

An increased tidal volume and respiratory rate lead to an increased minute volume and thus a decreased PaCO₂ (27 to 32mmHg), therefore a pregnant patient with respiratory failure may have a normal PaCO₂.

Gastrointestinal

Gastric emptying is slowed in pregnancy, increasing the risk of aspiration. A full stomach should be assumed in all pregnant patients, and a naso/orogastric tube inserted in those with an altered conscious state or intubated.

Stretching of the peritoneum decreases its sensitivity and may mask signs of peritonitis. The intestines are higher in the abdomen and shielded by the uterus, with liver and spleen position remaining unchanged.

Renal

Glomerular filtration rate and renal plasma blood flow increases during pregnancy, with a slight decrease in serum urea and creatinine. Glycosuria is common in pregnancy.

Mild hydronephrosis occurs in late pregnancy. The urinary bladder is pulled out of the pelvis by the enlarging uterus, increasing the risk of major trauma

Pregnancy Changes Summary	
Cardiovascular	
Blood pressure	Minimal change Slight ↓ in 1 st & 2 nd trimester, normal in 3 rd
Heart rate	↑15-20% ↑
Cardiac output	↑30-40% 6-7 L/min during pregnancy
ECG	Non-specific ST changes, Q waves in leads III & AVF, atrial and ventricular ectopic
Systemic Vascular resistance	↓ to 1000-14000 Due to progesterone and blood volume
Respiratory	
RR	No change
Oxygen demand	↑ 15%
FRC	↓ 25%
Minute Ventilation	↑25 -50% or 7-15 ml/min
Tidal Volume	↑ 25-40% or 8-10mls/kg
PaCO ₂	↑10 mmhg or 104-108mmHg
PaCO ₂	↓27-32 mmHg
Arterial pH	↑7.40-7.45
Bicarbonate	↓ 19-25mmol/l
Haematological	
Blood Volume (ml)	↑ 30-50% Volume ↑ with multiple gestations
WCC (mm ³)	↑ to 5,000-14,000
Haemoglobin (g/dL)	↓ to 100-140
Haemocrit (%)	32-42
Plasma volume (ml)	↑ 30-50%
RBC volume (ml)	↑ to 1900
Coagulation Factors	↑ factors VII, VIII, IX, XII
Platelet (mm ³)	200,00-350,000
Fibrinogen, plasma (mg/dL)	264-615
Renal	
Urea (mg/dL)	4-12
Sodium (mEq/L)	132-140
Potassium (mEq/L)	3.5-4.5
Chloride (mEq/L)	90-105
Calcium ionized (mEq/L)	4-5

APPENDIX 2 Pregnancy Complications	
Placental Abruption	
Signs	Symptoms
<ul style="list-style-type: none"> ▪ Uterine tenderness ▪ Bleeding, haemorrhagic shock ▪ Uterine tetany ▪ Expanding fundal height ▪ Evidence of fetal compromise (60% of cases) 	<ul style="list-style-type: none"> ▪ Vaginal bleeding ▪ Uterine irritability
Premature Membrane Rupture	
<ul style="list-style-type: none"> ▪ Ruptured membranes < 37 weeks in absence of contractions ▪ If the mother is stable and the pregnancy is viable and vaginal birth is possible, labour may be induced, but not necessarily immediately. If there is evidence of fetal compromise, birth will be expedited by the most appropriate method including caesarean section. 	
Uterine Rupture	
Occurs in 1% of pregnancies with blunt trauma and can be associated with pelvic fractures	
Signs	Symptoms
<ul style="list-style-type: none"> ▪ Smaller than expected symphysis-fundal height measurement for the gestation ▪ Oblique /transverse lie ▪ Hypovolaemic shock ▪ Fetal bradycardia or absence of fetal heart tones ▪ Rebound guarding 	<ul style="list-style-type: none"> ▪ Referred shoulder tip pain ▪ Severe pain ▪ Abdominal pain
Diagnosis	
<ul style="list-style-type: none"> ▪ Ultrasound can show extrusion of the uterine contents, or free fluid in pelvis or paracolic gutter ▪ Confirmation is by laparotomy. 	

Uterine contractions

- Most common side effect of trauma, due to release of prostaglandins. Whilst 70% will settle, some women may progress to labour.
- Labour can occur at any gestation
- Labour must NOT be suppressed when there is any placental abruption, maternal complications such as pre-eclampsia or hemodynamic instability

Diagnosis

- Is clinical
- Regular contractions
- Effacement and dilation of the cervix

Appendix 3 – Seat belt use during pregnancy

According to Australian Guidelines, correct use involves placing the seatbelt lap sash around hips and under pregnant belly, with the shoulder straps between breasts. However, many women place the lap sash directly over their pregnant abdomen. Correct placement has been shown to reduce the pressure exerted on the abdomen during impact, due to decreased impact with the steering wheel. Advice regarding correct seatbelt use should occur in antenatal visits; however this occurs less than half the time. Therefore, presentation to hospital following a motor vehicle accident provides an opportune time for healthcare professionals to counsel pregnant women regarding correct seatbelt use during pregnancy.³³

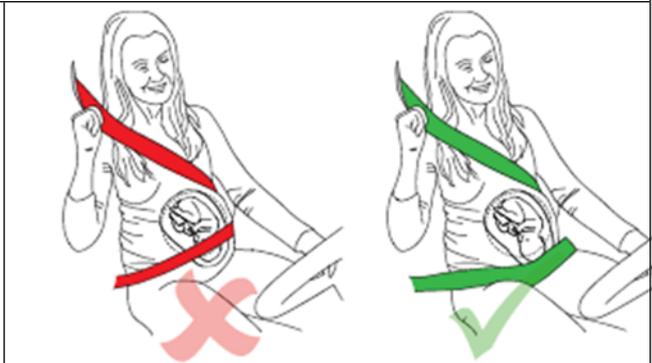
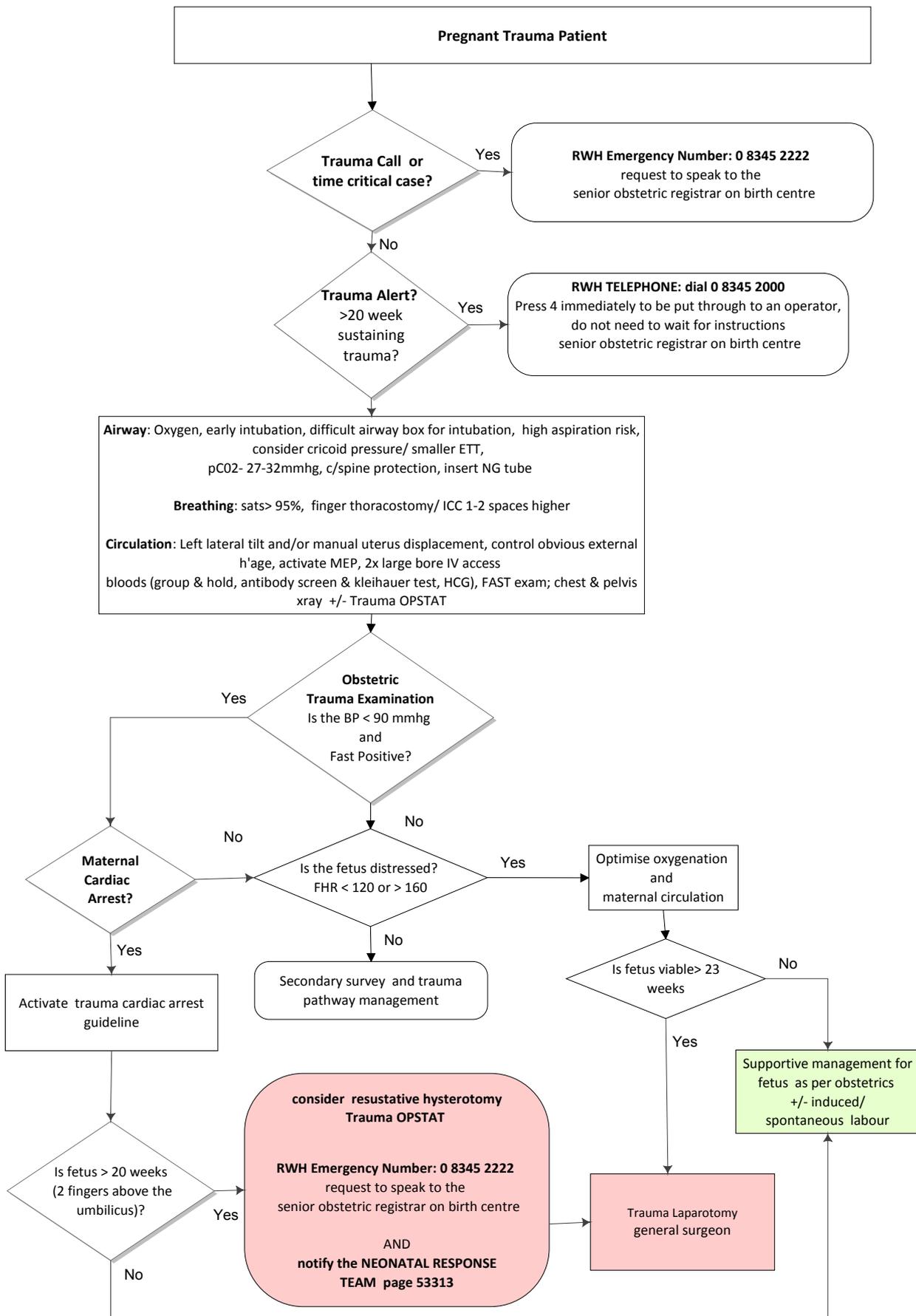
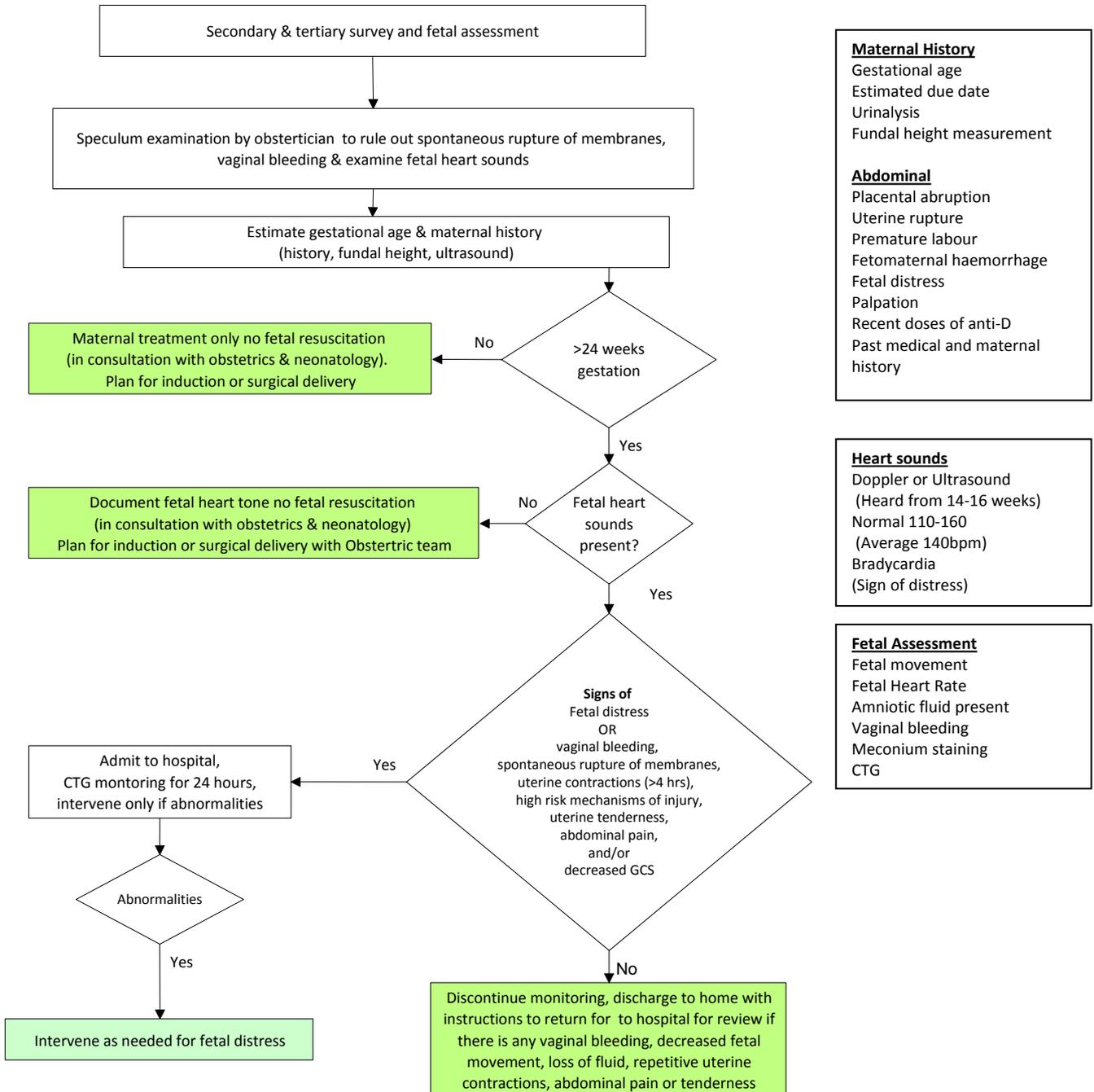


Image produced by: Clinical Multimedia Unit, Metro North Hospital and Health Service, Queensland.



Pregnant Trauma Patient Secondary and Tertiary Survey



Maternal History
 Gestational age
 Estimated due date
 Urinalysis
 Fundal height measurement

Abdominal
 Placental abruption
 Uterine rupture
 Premature labour
 Fetomaternal haemorrhage
 Fetal distress
 Palpation
 Recent doses of anti-D
 Past medical and maternal history

Heart sounds
 Doppler or Ultrasound
 (Heard from 14-16 weeks)
 Normal 110-160
 (Average 140bpm)
 Bradycardia
 (Sign of distress)

Fetal Assessment
 Fetal movement
 Fetal Heart Rate
 Amniotic fluid present
 Vaginal bleeding
 Meconium staining
 CTG

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