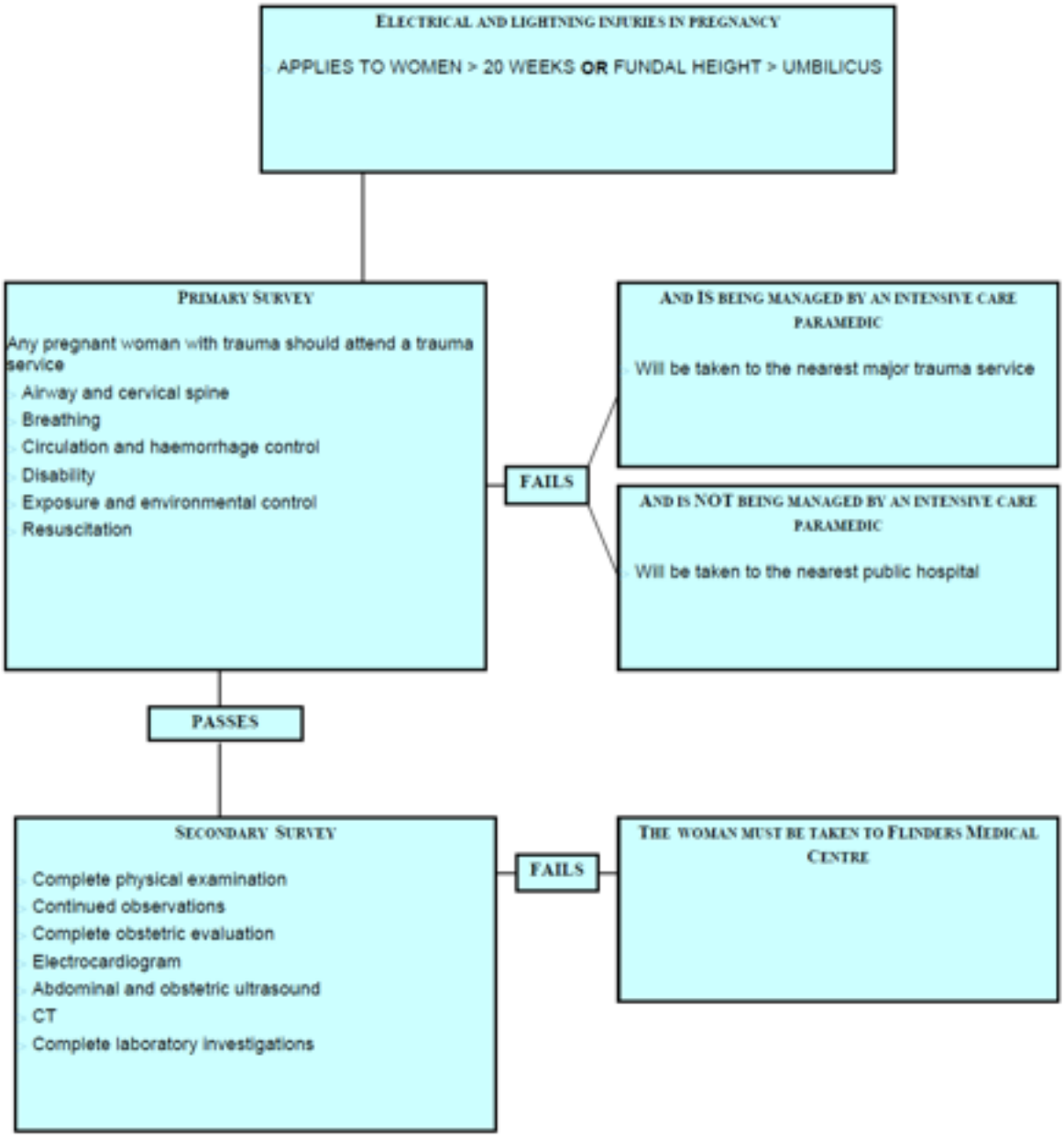
South Australian Perinatal Practice Guidelines

Electrical and lightning injuries in pregnancy

Electrical and lightning injuries in pregnancy flow chart



Introduction

- Reports of electrical injuries in pregnant women are exceedingly uncommon with minor electrical injuries rarely reported
- The spectrum of maternal electrical injury ranges from a transient unpleasant sensation and no effect on the fetus to sudden maternal and fetal death due to cardiac arrest (Muench & Canterino 2007)

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- The severity of maternal injury is not predictive of fetal outcome as significantly less current is required to produce injury to the fetus than in the mother
- Most electrical injuries pass from hand to hand with few adverse maternal effects
- Hand to foot transmission passes through the uterus and is associated with a high incidence of fetal death (immediate or several hours later) (Muench & Canterino 2007)
- Severe electrical / lightning trauma involves multisystem trauma and is best managed by a multi-specialty team (including an obstetrician) at the designated major trauma centre (for further information, refer to the PPG 'trauma in pregnancy')

Pathophysiology

- Electrical current causes damage through:
  - Direct process of physiological changes (altering cell resting membrane potential)
  - Conversion of electrical energy into thermal energy, causing massive tissue destruction and coagulative necrosis
  - Secondary damage associated with falls and violent muscle contractions

Electrical injury

- Electrical injury can be thermal, conductive, or caused by lightning. Conductive injuries are the most common
- The type of circuit involved may be either direct current (DC) or alternating current (AC).
  - High-voltage DC contact tends to cause a single muscle spasm, often throwing the victim from the source, and is usually less serious
  - AC exposure of the same voltage tends to be three times more dangerous than DC. Continuous muscle contraction or tetany can occur when the muscle fibres are stimulated. The hand is the most common site of contact with an AC electrical source, and contraction of the flexors of the wrist may pull the source closer to the body (Price & Cooper 2009)
- The type of circuit, duration, resistance of tissues, voltage, amperage and pathway of current will affect the nature and severity of electrical injury (Price & Cooper 2009)
  - The longer the contact, the greater the electro-thermal heating and degree of tissue destruction. Contact with water during the electrical injury will increase severity

Metropolitan pre-hospital trauma bypass

- Guidelines have been developed by the major trauma services and the SA Ambulance Service and supported by the Department of Health. Individuals with severe electrical / lightning trauma in the Adelaide metropolitan area are taken directly to one of the three major trauma services, Flinders Medical Centre (FMC) and Royal Adelaide Hospital (RAH) for adults and Women's and Children's (WCH) for children, bypassing urban hospitals

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- However, in rural areas trauma individuals are taken to the nearest hospital for assessment and then triaged in conjunction with advice from major trauma centres

Obstetric bypass

- Women who are more than 20 weeks pregnant or whose fundal height is higher than the umbilicus and suffer severe trauma should be cared for at a major trauma centre with an obstetric service. It depends on two main factors, the mother's injuries and the skill level of the paramedic attending the trauma incident
- If the woman fails the primary survey (see flow chart), and is being managed by an intensive care paramedic, she will be taken to the nearest major trauma service. If no intensive care paramedic is available, the woman will be taken to the nearest public hospital
- If the woman passes the primary survey but fails the secondary survey (see flow chart) she will be transported direct to FMC
- If the woman has very minor or no electrical injury but an assessment of the baby is required she will be taken to the nearest public hospital with an obstetric unit
- For pregnant women failing a primary survey and taken to the RAH, there is an arrangement for WCH obstetric involvement

General management principles

- The pregnant woman must be managed by the receiving hospital's usual trauma team following EMST principles. Initial emphasis must be on the assessment and resuscitation of the mother
- Obstetric assistance is added to the trauma team, by either an obstetrician attending the resuscitation, the ideal situation or giving telephone advice.
- The woman should be treated in the usual location where all trauma is managed, e.g. emergency department, resuscitation room etc
- An electrocardiogram should be instituted as soon as practicable but must not interfere unduly with treatment of the mother

Ongoing management.

- In cases of severe electrical injury, once the mother has been resuscitated and stabilised the next step is for her transfer to FMC for ongoing monitoring and management

Clinical considerations

- Exposure of different parts of the body to the same voltage will generate a different current (and by extension, a different degree of damage) because resistance varies significantly among various tissues (Price & Cooper 2009).
    - The least resistance is found in amniotic fluid, nerves, blood, mucous membranes, and muscles; the highest resistance is found in bones, fat, and tendons. Skin has intermediate resistance (Price & Cooper 2009)

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Maternal

- The current passing through the body can cause
  - Cardiac dysrhythmia
  - Asystole
  - Respiratory arrest
  - Muscle contraction
  - Tetany
  - Skeletal fractures
  - Neurologic injury
  - Placental abruption
- The conversion of electrical to thermal energy is responsible for various types of burns
- Skeletal fractures or blunt trauma may occur after loss of consciousness and a fall
- Cervical spine injury as a result of severe muscular contraction should be excluded
- Rhabdomyolysis can cause renal failure if adequate intravenous hydration is not maintained until myoglobinuria resolves
- Tissue necrosis may be extensive – consider antibiotic prophylaxis with penicillin to decrease risk of muscle and fascial infection
- Surgical consultation for wound care, debridement and fasciotomy as indicated
- Pregnant women with minor injuries must receive medical treatment for their injuries and appropriate fetal assessment

Fetal

- Fetal cardiac arrest (passage of current from maternal hand to foot)
- Fetal burns
- Reduced fetal movements
- Miscarriage

Management

- The management of pregnant women with moderate to severe injuries can be divided into:
  - Primary survey
  - Resuscitation
  - Secondary survey
  - Definitive treatment
- Many of the steps will occur simultaneously once the woman is received in the trauma centre or an emergency department

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- (for further information, refer to the PPG 'trauma in pregnancy')

Maternal assessment

- Manage multisystem trauma in cooperation with subspecialists
- The ABCs of cardiac and trauma care must be attended to first (for further information, refer to the PPG 'trauma in pregnancy')

History:

- Source of the electric shock
- The voltage involved
- Presence or absence of decreased skin resistance (e.g. environment)
- Presence of any tetany
- Loss of consciousness
- Burns
- Pathway of the current (entry and exit signs)

Physical examination

- Attention to vascular and neurologic signs and symptoms
- Look for subtle injuries including:
  - Tympanic membrane rupture (lightning injury)
  - Peripheral nerve injury
  - Vascular injury
  - Occult abdominal injury
  - Fractures
  - **AND** document the absence of conditions that may appear some time later
- Perform physical search for burns (the amount of deep tissue damage may initially not be apparent). Examine the entire body for unsuspected wounds
- Commence 12-lead electrocardiogram

Continuous cardiac monitoring is recommended if:

- Loss of consciousness
- Cardiac dysrhythmia
- Abnormal 12-lead electrocardiogram reading
- Abnormal mental status or physical examination findings
- Burn or tissue damage (risk of haemodynamic instability or electrolyte abnormalities)
- Known cardiovascular disease

Investigations

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- Urinalysis to evaluate for myoglobinuria (common complication of high voltage electrical injury). If the urine is pigmented or the dipstick is positive for blood, assume myoglobinuria
- Complete blood picture
- Electrolytes
- Blood urea nitrogen

Severe electrical injury or suspected intra-abdominal injury

- Pancreatic and hepatic enzymes
- Coagulation profile
- Perform cervical spine, chest and pelvic radiographs if previously unconscious as well as imaging of any injured limb

Major debridements necessary

- Group and save

Ventilation support

- Arterial blood gases
- Creatinine kinase (CK) and CKMB (or troponin)

Treatment

- Stabilise any life-threatening dysrhythmia
- Intravenous access and adequate intravenous hydration (crystalloid)
- Antibiotic prophylaxis as indicated
- Offer simple analgesia for muscle pain from tetany
- Wound and burn care as indicated

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Fetal surveillance

- Confirm the presence of fetal heart activity
- If the gestation is known to be or could be 24 weeks or more, electronic fetal monitoring (EFM) should be continued for a minimum of 4 hours for all women with minor electric / mechanical injury
- If the gestational age is unknown, a fundal height at the level of the umbilicus (20 centimetres or more) can be used as a guide until more accurate dating is possible
- Medical review after 4 hours continuous EFM
- EFM is indicated for 24 hours if:
    - Result of the maternal ECG is abnormal
    - History of maternal loss of consciousness
    - History of maternal cardiovascular disease
    - Uterine contractions > 1 every 15 minutes
    - Uterine tenderness
    - Signs of fetal compromise on cardiotocography
    - Evidence of vaginal bleeding
    - Rupture of the membranes
    - Positive Kleihauer test
    - Ultrasound suggestive of placental or cord abnormality
    - Any evidence of serious maternal injury
- Ultrasound as indicated
- Monitor fetus for oligohydramnios and fetal growth restriction for the rest of the pregnancy
- If discharge criteria (see below) are not met, intermittent EFM should be continued for 24 hours (at least one 20 minutes trace every 4 hours)

Discharge

Minor electrical injury

- Review after 4 hours of initial electronic fetal monitoring
- Discharge criteria:
    - No signs of fetal compromise
    - No uterine activity
    - No ruptured membranes
    - No vaginal bleeding
    - No evidence for feto-maternal haemorrhage on Kleihauer test
    - Normal ultrasound findings
    - Ensure all Rh (D) negative women with abdominal trauma have received a dose of 625 IU CSL Rh D immunoglobulin even if the Kleihauer test is negative
- Discharge home with instructions for the woman to return if:

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- Any signs of preterm labour
- Abdominal pain and / or vaginal bleeding
- Change in fetal movements

References

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Useful website:

PatientPlus. Electrical injuries and lightning strikes. Available from URL: http://www.patient.co.uk/doctor/Electrical-Injuries-and-Lightning-Strikes.htm

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Abbreviations

AC	Alternating current
DC	Direct current
ECG	Electrocardiogram
EFM	External fetal Monitoring
e.g.	For example
EMST	Early management of severe trauma
FMC	Flinders Medical Centre
%	Percent
RAH	Royal Adelaide Hospital
SA	South Australia
WCH	Women's and Children's Hospital

Version control and change history

PDS reference: OCE use only

Version	Date from	Date to	Amendment
1.0	22 May 12	current	Original version

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