Clinical Guideline
Electrical and Lightning Injuries in Pregnancy

Policy developed by: SA Maternal & Neonatal Community of Practice
Approved SA Health Safety & Quality Strategic Governance Committee on: 19 April 2016
Next review due: 19 April 2019

Summary
Clinical practice guideline for the management of electrical and lightning injuries in pregnancy

Keywords
clinical guideline, electrical and lightning injuries in pregnancy, coagulative necrosis, electrocardiogram, amniotic fluid, cardiac dysrhythmia, asystole, respiratory arrest, muscle contraction, tetany, skeletal fractures, neurologic injury, placental abruption, miscarriage, fetal burns, fetal cardiac arrest, reduced fetal movements, troponin, creatinine kinase, oligohydramnios, fetal growth restriction

Policy history
Is this a new policy? N
Does this policy amend or update an existing policy? Y 1.0
Does this policy replace an existing policy? N
If so, which policies?

Applies to
All SA Health Portfolio

Staff impact
All Staff, Management, Admin, Students, Volunteers
All Clinical, Medical, Nursing, Allied Health, Emergency, Dental, Mental Health, Pathology

PDS reference
CG231

Version control and change history

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South Australian Perinatal Practice Guidelines

electrical and lightning injuries in pregnancy

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Note

This guideline provides advice of a general nature. This statewide guideline has been prepared to promote and facilitate standardisation and consistency of practice, using a multidisciplinary approach. The guideline is based on a review of published evidence and expert opinion.

Information in this statewide guideline is current at the time of publication.

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Health practitioners in the South Australian public health sector are expected to review specific details of each patient and professionally assess the applicability of the relevant guideline to that clinical situation.

If for good clinical reasons, a decision is made to depart from the guideline, the responsible clinician must document in the patient's medical record, the decision made, by whom, and detailed reasons for the departure from the guideline.

This statewide guideline does not address all the elements of clinical practice and assumes that the individual clinicians are responsible for discussing care with consumers in an environment that is culturally appropriate and which enables respectful confidential discussion. This includes:

- The use of interpreter services where necessary,
- Advising consumers of their choice and ensuring informed consent is obtained,
- Providing care within scope of practice, meeting all legislative requirements and maintaining standards of professional conduct, and
- Documenting all care in accordance with mandatory and local requirements

Explanation of the aboriginal artwork:
The aboriginal artwork used symbolises the connection to country and the circle shape shows the strong relationships amongst families and the aboriginal culture. The horse shoe shape design shown in front of the generic statement symbolises a woman and those enclosing a smaller horse shoe shape depicts a pregnant women. The smaller horse shoe shape in this instance represents the unborn child. The artwork shown before the specific statements within the document symbolises a footprint and demonstrates the need to move forward together in union.

Australian Aboriginal Culture is the oldest living culture in the world yet Aboriginal people continue to experience the poorest health outcomes when compared to non-Aboriginal Australians. In South Australia, Aboriginal women are 2-5 times more likely to die in childbirth and their babies are 2-3 times more likely to be of low birth weight. The accumulative effects of stress, low socio economic status, exposure to violence, historical trauma, culturally unsafe and discriminatory health services and health systems are all major contributors to the disparities in Aboriginal maternal and birthing outcomes. Despite these unacceptable statistics the birth of an Aboriginal baby is a celebration of life and an important cultural event bringing family together in celebration, obligation and responsibility. The diversity between Aboriginal cultures, language and practices differ greatly and so it is imperative that Perinatal services prepare to respectively manage Aboriginal protocol and provide a culturally positive health care experience for Aboriginal people to ensure the best maternal, neonatal and child health outcomes.

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Contact: NeoMed@health.sa.gov.au
Electrical and lightning injuries in pregnancy flow chart

**Electrical and lightning injuries in pregnancy**

Applies to women > 20 weeks or fundal height > umbilicus

**Primary Survey**

Any pregnant woman with trauma should attend a trauma service
- Airway and cervical spine
- Breathing
- Circulation and haemorrhage control
- Disability
- Exposure and environmental control
- Resuscitation

If fails, the woman must be taken to Flinders Medical Centre

If passes and is being managed by an intensive care paramedic,
- Will be taken to the nearest major trauma service

If passes and is not being managed by an intensive care paramedic,
- Will be taken to the nearest public hospital

**Secondary Survey**

- Complete physical examination
- Continued observations
- Complete obstetric evaluation
- Electrocardiogram
- Abdominal and obstetric ultrasound
- CT
- Complete laboratory investigations
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
> 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 or head to foot transmission passes through the uterus and is associated with a high incidence of fetal death (immediate or several hours later)
> 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 on SA trauma system see ‘Trauma in pregnancy’ in the A to Z index at www.sahealth.sa.gov.au/perinatal)

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
> Pathophysiology of electrical injury is not well understood due to large number of variables influencing the effect of the current through the body

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
> The type of circuit, duration, resistance of tissues, voltage, amperage and pathway of current will affect the nature and severity of electrical injury
  > 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
> Contact with both hands results in transthoracic pathway, which accounts for most of the mortality
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.

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 Early management of severe trauma (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.

- 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.
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.

Cutaneous burns at the point of contact with the electrical source and the ground represent the most devastating injuries. The most common sites are hands, heels and head. They usually affect 10-25% of the total body surface area and vary from superficial partial-thickness burns to full-thickness 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

See ‘Trauma in pregnancy’ in the A to Z index at www.sahealth.sa.gov.au/perinatal for further information on above

Maternal assessment
- Manage multisystem trauma in cooperation with subspecialists
- The ABCs of cardiac and trauma care must be attended to first (see ‘Trauma in pregnancy’ in the A to Z index at www.sahealth.sa.gov.au/perinatal)

History:
- Source of the electric shock

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> 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**
> 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**
Electrical and lightning injuries in pregnancy

- 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

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

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> Discharge home with instructions for the woman to return if:
>  > Any signs of preterm labour
>  > Abdominal pain and / or vaginal bleeding
>  > Change in fetal movements

References

Useful website:
Abbreviations

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<tr>
<td>AC</td>
<td>Alternating current</td>
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<td>CK</td>
<td>Creatinine kinase</td>
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<td>DC</td>
<td>Direct current</td>
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<td>ECG</td>
<td>Electrocardiogram</td>
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<td>EFM</td>
<td>External fetal monitoring</td>
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<td>EMST</td>
<td>Early management of severe trauma</td>
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<td>FMC</td>
<td>Flinders Medical Centre</td>
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<td>IU</td>
<td>International units</td>
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<td>%</td>
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<td>RAH</td>
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<td>Rh</td>
<td>Rhesus factor</td>
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<td>South Australia</td>
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<tr>
<td>WCH</td>
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