Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Hypertensive disorders of pregnancy

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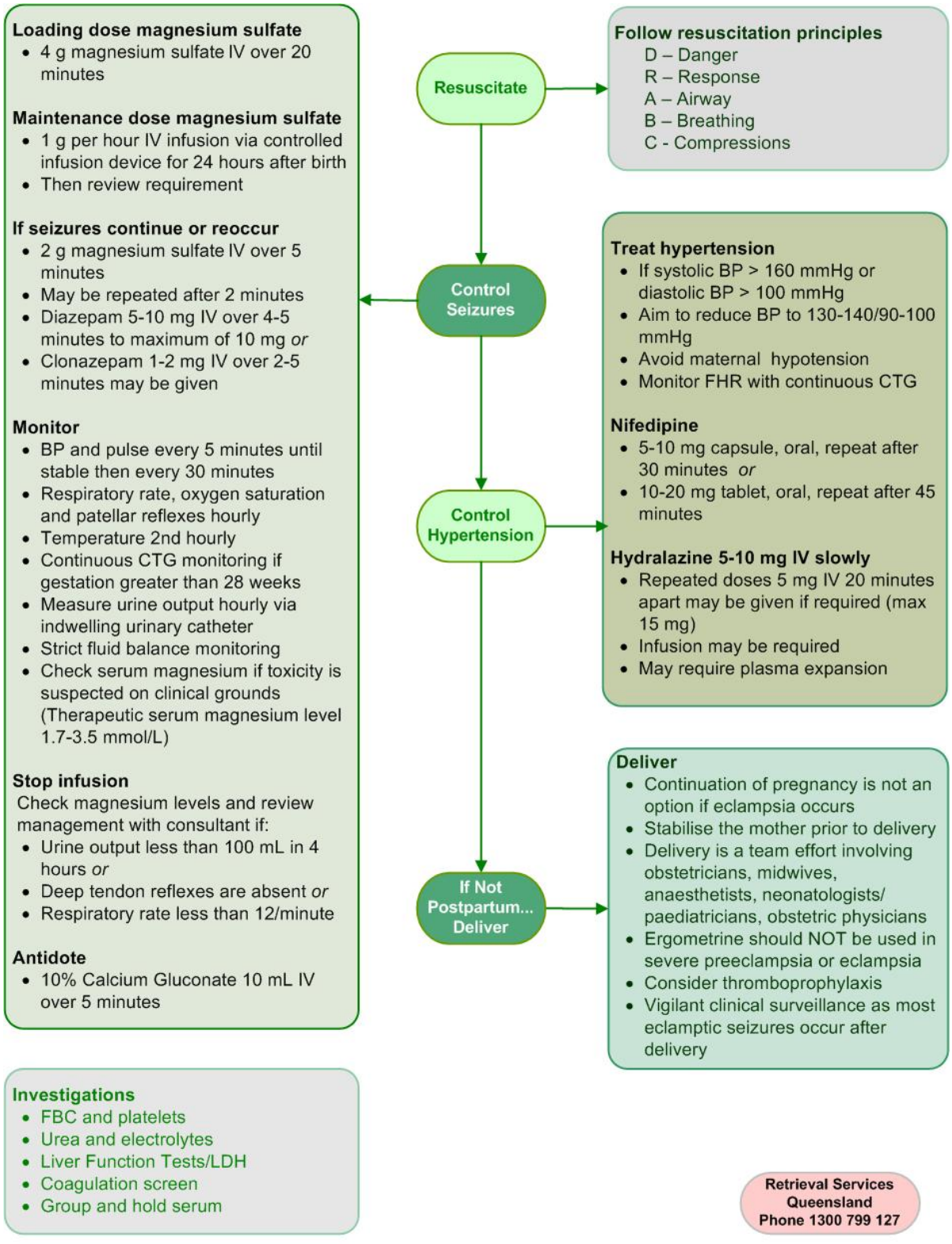
This Guideline does not address all elements of standard practice and assumes that individual clinicians are responsible to:

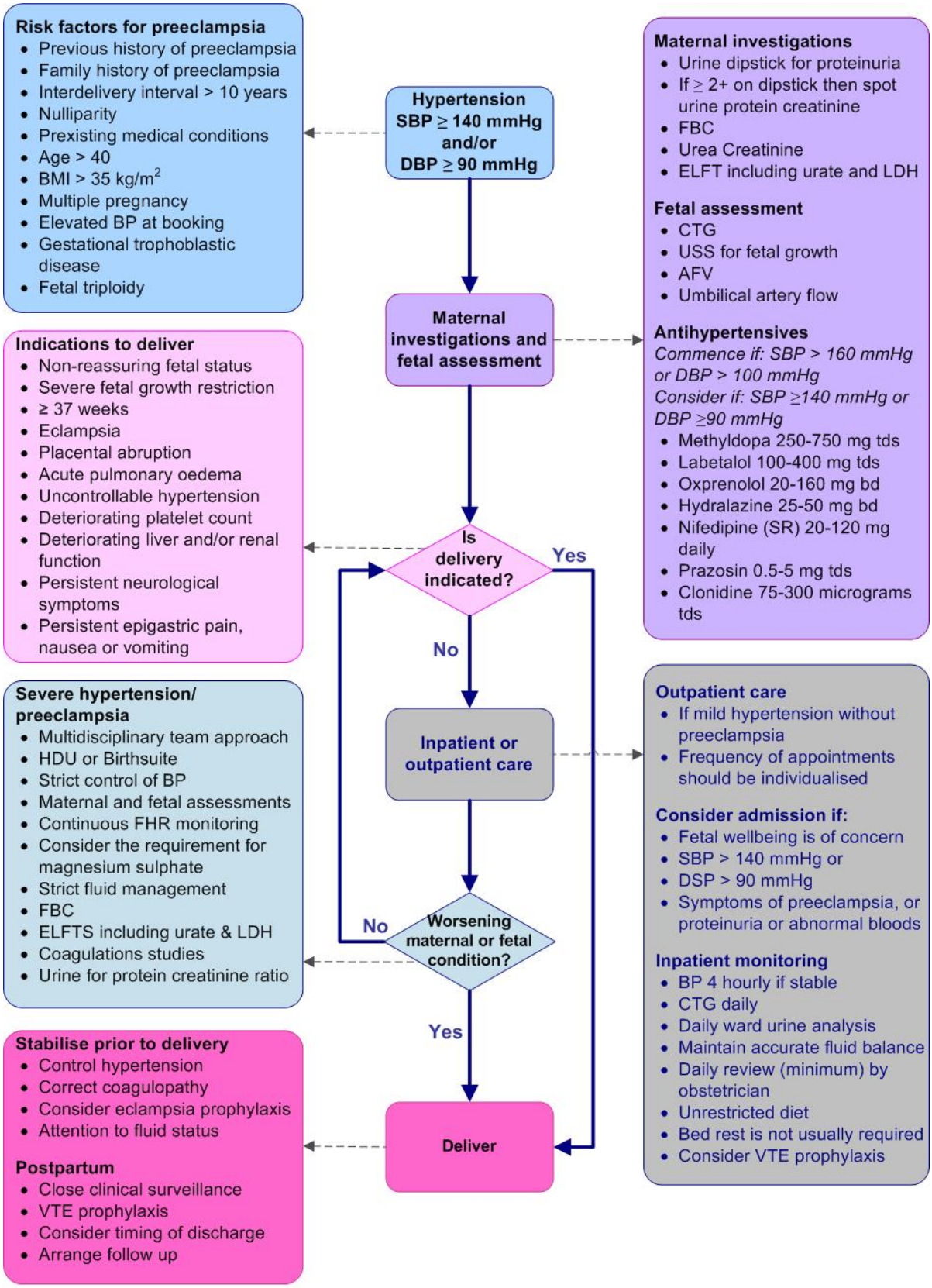
- Discuss care with consumers in an environment that is culturally appropriate and which enables respectful confidential discussion. This includes the use of interpreter services where necessary
- Advise consumers of their choice and ensure informed consent is obtained
- Provide care within scope of practice, meet all legislative requirements and maintain standards of professional conduct
- Apply standard precautions and additional precautions as necessary, when delivering care
- Document all care in accordance with mandatory and local requirements

Flowchart: Management of eclampsia



Adapted from: Algorithm 16.1 Preeclampsia/eclampsia *in* The Moet course manual: managing obstetric emergencies and trauma (2007)
Statewide Maternity and Neonatal Clinical Guidelines Program: Hypertensive disorders in pregnancy. Guideline No: MN10.13-V4-R15

Flowchart: Summary management of hypertensive disorders of pregnancy



Statewide Maternity and Neonatal Clinical Guideline: Hypertensive Disorders of Pregnancy MN10.13-V4-R15

Abbreviations

ACE	Angiotensin converting enzyme
AFV	Amniotic fluid volume
ALT	Alanine aminotransferase
aPPT	Activated partial thromboplastin time
AST	Aspartate aminotransferase
bd	Twice daily
BMI	Body mass index
BP	Blood Pressure
CPR	Cardiopulmonary resuscitation
CTG	Cardiotocograph
DBP	Diastolic blood pressure
DIC	Disseminated intravascular coagulation
ECG	Electrocardiograph
ELFT	Electrolytes and Liver Function Test
FBC	Full blood count
FHR	Fetal heart rate
Hb	Haemoglobin
HDU	High dependency unit
INR	International normalised ratio
IUGR	Intrauterine growth retardation
IUFD	Intrauterine fetal death
IV	Intravenous
LDH	Lactate dehydrogenase
LFT	Liver Function Test
mmHg	Millimetres of mercury
NSAIDS	Non-steroidal anti-inflammatory drugs
PCR	Protein creatinine ratio
RR	Respiratory rate
SBP	Systolic blood pressure
SLE	Systemic lupus erythematosus
SR	Slow release
tds	Three times per day
USS	Ultrasound scan
VTE	Venous thromoboembolism
WBC	White blood cell

Terminology

Local facilities may differentiate the roles and responsibilities assigned in this document to an “Obstetrician” according to their specific practitioner group requirements; for example to General Practitioner Obstetricians, Specialist Obstetricians, Consultants, Senior Registrars, Obstetric Fellows or other members of the team as required.

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1 Introduction

Hypertension is the most common medical problem encountered in pregnancy[1] and is a leading cause of perinatal and maternal morbidity and mortality.[2] Pregnant women with hypertension are more likely to develop placental abruption, disseminated intravascular coagulation (DIC), cerebral haemorrhage, hepatic failure and acute renal failure.[2]

1.1 Definition

Hypertension is defined as[3]:

- systolic blood pressure (BP) greater than or equal to 140 mmHg and/or
- diastolic BP greater than or equal to 90 mmHg

A rise in systolic BP greater than or equal to 30 mmHg and/or a rise in diastolic BP greater than or equal to 15 mmHg *may* be significant in some women[2,3] but is not included in the definition. Assess these women for clinical and laboratory features of preeclampsia.

1.1.1 Severe hypertension in pregnancy

Severe hypertension is defined as[4,5]:

- systolic BP greater than or equal to 160 mmHg and/or
- diastolic BP greater than or equal to 110 mmHg

Severe hypertension requires urgent assessment and management.

1.1.2 White coat hypertension

Hypertension in a clinical setting with normal BP in a non-clinical setting when assessed by 24 hour ambulatory BP monitoring or home BP monitoring using an appropriately validated device.[3]

1.2 Measurement of BP

- Correct measurement techniques are critical to the correct diagnosis of hypertensive disorders in pregnancy[6] [refer to Appendix A: Measurement of blood pressure]
- Confirm hypertension with repeated readings over several hours[3] in an inpatient or outpatient setting

2 Classification

Hypertension can be classified as follows[3]:

- preeclampsia – eclampsia
- gestational hypertension
- chronic hypertension
  - essential
  - secondary
  - white coat
- preeclampsia superimposed on chronic hypertension

The term pregnancy induced hypertension (PIH) should not be used as its meaning in clinical practice is unclear.[7]

2.1 Preeclampsia

A multi-system disorder characterised by hypertension and involvement of one or more other organ systems and/or the fetus. Raised BP is commonly but not always the first manifestation. Proteinuria is also common but should not be considered mandatory to make the clinical diagnosis.[3]

Diagnosis can be made when:

- hypertension arises after 20 weeks gestation
  - confirmed on 2 or more occasions
- accompanied by one or more of:
  - significant proteinuria
    - random urine protein/creatinine ratio greater than or equal to 30 mg/mmol
    - 24 hour urine excretion not generally required
  - renal involvement
    - serum or plasma creatinine greater than or equal to 90 micromol/L or
    - oliguria
  - haematological involvement
    - thrombocytopenia
    - haemolysis
    - DIC
  - liver involvement
    - raised transaminases
    - severe epigastric or right upper quadrant pain
  - neurological involvement
    - severe headache
    - persistent visual disturbances (photopsia, scotomata, cortical blindness, retinal vasospasm)
    - hyperreflexia with sustained clonus
    - convulsions (eclampsia)
    - stroke
  - pulmonary oedema
  - intrauterine fetal growth restriction (IUGR)
  - placental abruption

2.2 Gestational hypertension

- New onset of hypertension arising after 20 weeks gestation
- No additional features of preeclampsia
- Resolves within 3 months postpartum

The earlier the gestation at presentation and the more severe the hypertension, the higher the likelihood of developing preeclampsia or an adverse pregnancy outcome.[3]

2.3 Chronic hypertension

Pre-existing hypertension is a strong risk factor for the development of preeclampsia[3] and requires close clinical surveillance.

2.3.1 Essential

- BP greater than 140/90 mmHg preconception or prior to 20 weeks without an underlying cause or
- BP less than 140/90 entering pregnancy on antihypertensives

2.3.2 Secondary

Hypertension due to:

- chronic kidney disease (e.g. glomerulonephritis, reflux nephropathy and adult polycystic kidney disease)
- renal artery stenosis
- systemic disease with renal involvement (e.g. diabetes mellitus, systemic lupus erythematosus)
- endocrine disorders (e.g. phaeochromocytoma, Cushing's syndrome and primary hyperaldosteronism)
- coarctation of the aorta

2.4 Preeclampsia superimposed on chronic hypertension

Diagnosed where a woman with pre-existing hypertension develops:

- systemic features of preeclampsia
- after 20 weeks gestation

3 Antenatal assessment

Goals of antenatal monitoring are to:

- control blood pressure
- recognise preeclampsia early[3]
- prevent eclampsia
- optimise birth for both the woman and the fetus[2]

3.1 Risk factors for preeclampsia

- Preeclampsia in a previous pregnancy[8]
- Family history of preeclampsia[1,8]
- Poor outcome in a prior pregnancy (placental abruption, IUGR, fetal death in utero)
- Interdelivery interval greater than 10 years[1,8]
- Nulliparity[1,8]
- Pre-existing medical conditions
    - chronic hypertension[1,8]
    - diabetes (pre-existing or gestational)[1,8]
    - renal disease[1,8]
    - thrombophilias
        - antiphospholipid syndrome[1,8]
        - protein C and S deficiency
        - antithrombin III deficiency and
        - Factor V Leiden
- Maternal age greater than or equal to 40 years[1,8]
- Body Mass Index (BMI)[1] greater than 35 kg/m^2
- Multiple pregnancy[1,8]
- Raised BP at booking[8]
- Gestational trophoblastic disease
- Fetal triploidy

3.2 Maternal investigations

Tests may be abnormal even when BP elevation is minimal.[2]

- Urine dipstick testing for proteinuria[3]
  - Quantitation by laboratory methods if greater than or equal to "2+"
  - Spot urine protein:creatinine can be used to detect significant proteinuria (greater than 30mg/mmol)
  - 24 hour urine collection is not necessary in routine clinical management[9]
- Full blood count (FBC)[3]
- Urea, creatinine, electrolytes[3] including lactate dehydrogenase (LDH) and urate
- Liver function tests (LFT)[3]

3.2.1 Preeclampsia investigations

If features of preeclampsia are present additional investigations should include[3]:

- urinalysis and microscopy on a carefully collected mid-stream urine sample
- if there is thrombocytopenia or a falling haemoglobin, investigations for DIC
  - coagulation studies
  - blood film
  - LDH
  - fibrinogen

[refer to Appendix B: Maternal investigations].

3.3 Fetal assessment

- Cardiotocograph (CTG)
- Ultrasound scan (USS) assessment of:
  - fetal growth[2]
  - amniotic fluid volume (AFV)
  - umbilical artery flow (Doppler)

Table 1. Fetal investigations

Fetal investigation	Description if preeclampsia
Fetal movement count	Decreased
Non-stress test	Non-reassuring FHR
Biophysical profile	Lower score
Deepest amniotic fluid pocket	Lower
USS assessment of fetal growth	Usually asymmetrical intrauterine fetal growth
Umbilical artery flow Doppler	Increased resistance, absent or reversed end diastolic flow

4 Models of antenatal care

4.1 Outpatient care

- Suitable for women with mild hypertension without evidence of preeclampsia and where
  - there are no geographic contraindications
- Consider combined obstetric and physician outpatient management if there is:
  - previous pregnancy complicated by preeclampsia
  - known essential hypertension on treatment
  - known renal disease or recurrent urinary tract infection
  - other disease associated with hypertension (e.g. systemic lupus erythematosus)
- Frequency of appointments is based on the individual clinical requirements of the woman

4.2 Antenatal day assessment

An alternative to inpatient stay or an adjunct to close antenatal surveillance in selected patients.[10] Frequent maternal and fetal surveillance is required[2] with:

- regular (daily) review by an obstetrician and
- when there is a change to maternal or fetal condition

4.3 Antenatal inpatient care

Consider admission to hospital where[3]:

- there is concern for fetal wellbeing and/or
- BP is greater than 140 mmHg systolic or 90 mmHg diastolic with
  - symptoms of preeclampsia or
  - proteinuria or
  - abnormalities in the blood investigations

4.3.1 Monitoring during inpatient care

- BP 4 hourly if stable
- CTG daily (from 28 weeks gestation)
- Daily ward urine analysis
- Maintain accurate fluid balance record
- Daily review (minimum) by obstetrician
- Unrestricted diet
- Bed rest is not usually required[3] and may be harmful[10]
- Consider graduated elastic compression stockings with or without low molecular weight heparin.[3] [refer to Guideline: *Venous thromboembolic prophylaxis in pregnancy and the puerperium*]

4.4 Transfer of care

Management options will depend on the services available at each facility. Consultation with and/or transfer to a higher level service may be indicated for:

- preterm pregnancies (24-32 weeks gestation)[3] with preeclampsia, severe preeclampsia, eclampsia or HELLP syndrome
- term pregnancies complicated by eclampsia or HELLP syndrome
- any pregnancy in which the health care provider believes the health care facility will be unable to manage the complications of hypertension of pregnancy

Consider magnesium sulfate therapy prior to transfer in women with severe preeclampsia, eclampsia or HELLP syndrome.

If transfer is indicated the relevant obstetric medical coordinator should be contacted via Retrieval Services Queensland (RSQ) on 1300 799 127.

5 Ongoing surveillance

- Severity, timing, progression and onset of clinical features are unpredictable[1]
- Hypertension and proteinuria may be late or mild features of preeclampsia[1]
- Management of women with preeclampsia less than 32 weeks gestation should be restricted to centres with facilities for preterm birth[3]
- Serial surveillance of maternal and fetal wellbeing is recommended[2,7]
- A multidisciplinary team approach is required which may include[3,7,11]:
  - experienced obstetric staff
  - experienced midwives
  - obstetric physician
  - anaesthetist
  - neonatologist/paediatrician
- Frequency, intensity and modality of maternal and fetal surveillance will depend on individual maternal and fetal characteristics. Suggested protocols are outlined in Table 2 and Table 3[3]

5.1 Maternal surveillance

[refer to Appendix B: Maternal investigations]..

Table 2. Ongoing maternal surveillance[3]

Classification	Modality	Frequency
Gestational hypertension	• Urinalysis for protein • Preeclampsia bloods	• 1-2 per week • Weekly
Preeclampsia	• Urinalysis for protein • Preeclampsia bloods	• At time of diagnosis: if non-proteinuric repeat daily • Twice weekly or more if unstable
Chronic hypertension	• Urinalysis for protein • Preeclampsia bloods	• Each visit • If sudden increase in BP or new proteinuria

5.2 Fetal surveillance

Adverse perinatal outcome is increased in women with all subcategories of hypertensive disease in pregnancy as compared to normotensive women.[2,3]

- Assessment of growth trends by serial USS is recommended[3]
- Symphysis-fundal height measurement is a poor screening tool for detection of fetal growth restriction[3]

Table 3. Ongoing fetal surveillance[3]

Classification	Modality	Frequency
Gestational hypertension	• USS for fetal growth/AFV/Doppler	• At time of diagnosis and 3-4 weekly
Preeclampsia	• USS for fetal growth/AFV/Doppler • CTG	• At time of diagnosis and 2-3 weekly • Twice weekly
Preeclampsia with fetal growth restriction	• CTG • USS for fetal growth/AFV/Doppler	• Twice weekly • On admission and 2nd weekly
Chronic hypertension	• Early dating USS • USS for fetal growth/AFV/Doppler	• First trimester • Third trimester: 4th weekly

6 Treatment of hypertension

The aim of antihypertensive treatment is to achieve a gradual and sustained lowering of BP to:

- prevent maternal cerebral haemorrhage and eclampsia[9]
- allow prolongation of pregnancy for fetal benefit[3]

6.1 Mild-moderate hypertension

There is controversy regarding the need to treat mild to moderate hypertension[3]

- **Consider** treatment if:
  - systolic BP is 140-160 mmHg and/or
  - diastolic BP is 90-100 mmHg and/or
  - there are associated signs and symptoms of preeclampsia[12]
- First line drugs include: Methyldopa, Labetalol, Oxprenolol
- Second line drugs include: Hydralazine, Nifedipine, Prazosin
- Angiotensin converting enzyme (ACE) inhibitors and angiotensin receptor blockers are contraindicated in pregnancy[3,13]

[refer to Appendix D: Maintenance antihypertensive medications]

6.2 Hypertension requiring treatment

- **Commence** treatment if [3,12]:
  - systolic BP is greater than 160 mmHg and/or
  - diastolic BP is greater than 100 mmHg
- The antihypertensive agent of choice for acute control has not been established[12]
- Initial therapy can be with one of a variety of antihypertensive agents[3,7,11,12,14]
- Persistent or refractory severe hypertension may require repeated doses[3]
- The concurrent administration of longer acting oral agents will achieve a more sustained blood pressure lowering effect[3]
- The following drugs are not generally recommended[12]
  - magnesium sulfate (although it may be indicated for prevention of eclampsia)
  - high dose diazoxide
  - nimodipine
  - chlorpromazine
- Infusions of sodium nitroprusside or glyceryl trinitrate are recommended only when other treatments have failed and birth is imminent[3]

[refer to Table 4 and Appendix C: Hydralazine protocol, Appendix D: Maintenance antihypertensive medications, Appendix E: Magnesium sulfate protocol].

Table 4. Drugs for acute severe hypertension

Drug	Dose	Route	Onset of Action
Nifedipine	5-10 mg capsule	Oral	10-20 minutes Repeat after 30 minutes
	10-20 mg tablet	Oral	30-45 minutes Repeat after 45 minutes
Hydralazine	5-10 mg	IV bolus	20 minutes Repeat after 20 minutes
Diazoxide	15-45 mg maximum 300 mg	IV rapid bolus	3-5 minutes Repeat after 5 minutes
Labetalol	20-50 mg	IV bolus over 2 minutes	5 minutes Repeat after 15-30 minutes

6.2.1 Management of severe hypertension

- A multidisciplinary team approach is required[11]
- If undelivered, management should occur in a high dependency unit[3] or birth suite[1]
- A sudden and precipitous drop in BP should be avoided so blood flow to the fetus is not compromised[12]
  - Strict control of BP is required
  - Monitor BP frequently (15-30 minutes until stable) and then 4 hourly[11]
- Perform assessment of maternal and fetal condition as per [section 3.2 and 3.3]
  - Continuous fetal heart rate (FHR) monitoring is recommended
  - Oxygen saturation monitoring may be required

7 Preeclampsia considerations

7.1 Indications for magnesium sulfate use

Magnesium sulfate is the anticonvulsant drug of choice for the prevention and treatment of eclampsia.[9,15]

- Magnesium sulfate should not be prescribed for the prevention of eclampsia without discussion with a Consultant Obstetrician
- Treatment is recommended during the antepartum, intrapartum and within the first 24 hours postpartum for preeclampsia with evidence of central nervous system dysfunction
- Magnesium sulfate should be continued for 24 hours after birth
- Facilities should develop dilution/preparation protocols for magnesium sulfate

[refer to Appendix E: Magnesium sulfate protocol].

7.2 Fluid management

Administration of large volumes of intravenous fluids before or after birth may cause pulmonary oedema or worsen peripheral odema.[3]

- Monitor fluid balance and chart input and output[11]
- If no other complications, restrict post-birth intravenous crystalloids to 1500 ml in the first 24 hours
- An indwelling urinary catheter for hourly measurements may be required[11]
- Diuretics are usually inappropriate unless there is fluid overload or pulmonary oedema
- For oliguria (less than 15 mL/hr)
  - obstetric and medical review is required
  - neither dopamine nor frusemide is recommended[7]

7.3 HELLP syndrome

A variant of severe preeclampsia (**H**aemolysis, **E**levated **L**iver enzymes and **L**ow **P**latelet) count. Elements include:

- thrombocytopenia (common)
- haemolysis (rare) and
- elevated liver enzymes (common)

In a woman with preeclampsia, the presence of any of the following is an indicator of severe disease

- maternal platelet count of less than 100,000 x 10^9/L
- elevated transaminases
- microangiopathic haemolytic anaemia with fragments/schistocytes on blood film

7.3.1 Management of HELLP syndrome

- Liaise with Consultant Obstetrician, Obstetric Physician or Haematologist
- Consider platelet transfusion if:
  - platelet count precludes epidural anaesthesia or
  - presents a hazard to operative birth, or
  - there is significant bleeding postpartum attributable to preeclamptic thrombocytopenia

8 Eclampsia

Eclampsia is defined as the occurrence of one or more seizures superimposed on preeclampsia.[11,15] The aims of treatment are to terminate the seizure, prevent recurrence, control hypertension and prevent maternal and fetal hypoxia.[3]

- More than one-third of women experience their first seizure before the development of hypertension and proteinuria[1]
- Seizures may occur antepartum (38%), intrapartum (18%) or postpartum (44%)[1,14]
- Teenagers are three times more likely to suffer eclampsia than older women[1]

[refer to the flow chart “Management of Eclampsia” on page 3 of this guideline].

8.1 Seizure treatment

- Follow the basic principles of resuscitation
- Magnesium sulfate is the anticonvulsant drug of choice for the prevention and treatment of eclampsia[9,11,15] [refer to Appendix E: Magnesium sulfate protocol]
  - If the seizure is prolonged, IV diazepam (2 mg/minute to a maximum of 10 mg) or clonazepam (1-2 mg over 2-5 minutes) may be given[3]
- Phenytoin should not be used for eclampsia prophylaxis or treatment unless there is a contraindication to magnesium sulfate or it is ineffective[7,15]

8.2 Post seizure care

- If undelivered, delivery should be arranged once the woman’s condition is stable
- Close clinical surveillance is required

9 Delivery considerations

- The only cure for preeclampsia is birth[1,16]
- Corticosteroids should be given if the fetus is less than 34 weeks gestation and birth can be deferred[3,7,11]
- The anaesthetist should be informed when a woman with preeclampsia is admitted to birth suite[2,7]
- Except where there is acute fetal compromise, birth should be preceded by stabilisation of the woman including:
  - control of eclampsia or prophylaxis against eclampsia if indicated
  - control of severe hypertension[3]
  - correction of coagulopathy
  - attention to fluid status

9.1 Indications to deliver

- Non-reassuring fetal status[2,3]
- Severe fetal growth restriction[2,3]
- Gestational age greater than or equal to 37 weeks[3,17]
- Eclampsia[3]
- Placental abruption[3]
- Acute pulmonary odema[3]
- Inability to control hypertension[3] despite adequate antihypertensive therapy[13]
- Deteriorating platelet count[2,3]
- Deteriorating liver function[2,3]
- Deteriorating renal function[2,3]
- Persistent neurological symptoms[3]
- Persistent epigastric pain, nausea or vomiting[2] with abnormal liver function tests[3]

9.2 Mode of birth

- Vaginal birth should be considered unless a caesarean section is required for other obstetric indications[2,7]
- If vaginal birth is planned and the cervix is unfavourable, then cervical ripening should be recommended to increase the chance of successful vaginal birth[2]
- Antihypertensive treatment should be continued throughout labour and birth to maintain systolic BP at less than 160 mmHg and diastolic BP less than 110 mmHg

9.3 Intrapartum

- Consult early with an anaesthetist, obstetrician and obstetric physician[3] where feasible
- Continue oral antihypertensive medications unless BP is less than 120 /70 mmHg
- Close clinical surveillance is required
  - Monitor BP ½ hourly
  - Continuous electronic fetal monitoring is recommended[11]
- IV access is required
- An epidural (in the absence of contraindications) is a useful adjunct therapy for BP control[3]
- Assistance with 2nd stage is not routinely required but may be necessary if:
  - BP is poorly controlled
  - progress is inadequate
  - there are premonitory signs of eclampsia
- Active management of third stage is recommended due to the increased risk of post partum haemorrhage
- Ergometrine or syntometrine should NOT be given as it may produce an acute rise in BP[7,11]

10 Postpartum

Hypertension, proteinuria, eclampsia and other adverse conditions of preeclampsia may develop for the first time postpartum.

- Close monitoring (4 hourly or more frequently) including BP, pulse rate, respiratory rate, temperature and oxygen saturation should continue until:
  - BP is stable
  - urine output has normalised
  - blood investigations are stable or improving
- A reduction in frequency of monitoring should be approved by the treating Obstetric/ Medical team
- Postpartum thromboprophylaxis should be considered unless contraindicated
- Non-steroidal anti-inflammatory drugs (NSAIDS) are not generally recommended because of the risk of worsening hypertension and renal impairment, especially in volume depleted women
- It is usually possible to stop antihypertensive medication by 6 weeks postpartum in women who develop hypertension during pregnancy
- Appropriate postnatal counselling regarding the pregnancy and birth experience should be provided
- All drugs in Appendix D are considered compatible with breast feeding[3]

10.1 Discharge

- Timing of discharge should take into account the risk of late seizures
- A careful review before discharge is required[11]
- Timing of follow-up should be individualised

10.2 Care beyond 6 weeks postpartum

- Formal postnatal review to discuss the events of the pregnancy should be offered to women whose pregnancies have been complicated by severe preeclampsia[2,11]
- Pre-conceptual counselling should be offered, where risk factors and preventative therapies (e.g. calcium supplementation, low dose aspirin) can be discussed[2,11]
- Screening for pre-existing hypertension, underlying renal disease and thrombophilia should be offered to women with a history of severe preeclampsia[3,7]
- Ongoing assessment of traditional cardiovascular risk markers is of benefit to women who are normotensive but who had a hypertensive disorder of pregnancy
- Overweight women should be encouraged to attain a healthy BMI for long term health and to decrease risk in future pregnancy[7]

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Appendix A: Measurement of blood pressure

Technique	Procedure[6]	Rationale
Position of woman	• Seated[18] • Feet supported on a flat surface • Arm supported horizontally at the level of the heart • Allow to rest for 5 minutes prior to measurement[18] • Supine posture should be avoided • In labour, use left arm in lateral recumbency • Measure using both arms at initial visit[18]	• Different arm positions can produce significantly different measurements • A rise in BP may occur in the first few minutes of a medical encounter • Avoids supine hypotension syndrome • Excludes rare vascular abnormalities
Cuff size	• Cuff length 1.5 times the circumference of the arm • If arm circumference greater than 33 cm use large cuff or extra large cuff	• Correct sized cuff prevents over diagnosis
Cuff position	• Place lower edge of cuff 2-3 cm above the point of brachial artery pulsation • Place rubber tubes from cuff bladder superiorly	• Allows easy access to the antecubital fossa for auscultation
Measurement device	• Calibrate and maintain device as per manufacturer's instructions	• All devices require regular servicing and calibrating[18]
Systolic BP measurement	• Palpate BP at the brachial artery • Inflate cuff to 30 mmHg above where pulse disappears[18] • Deflate cuff slowly at approximately 2 mmHg per second[18] • Use Korotkoff phase I (first sound heard) • Readings should be taken to the nearest 2 mmHg (not nearest 0 or 5 mmHg)	• Palpation of the brachial artery is required to ensure correct placement of the stethoscope • Necessary for accurate systolic and diastolic estimation[18] • Avoids bias through digit preference (i.e. observers estimating BP to nearest 0 or 5 mmHg)
Diastolic BP measurement	• Record diastolic BP using Korotkoff phase V (i.e. when sounds disappear) • If phase V can not be detected use Korotkoff phase IV (i.e. when sounds muffle) • If BP consistently higher in one arm, the arm with the higher values should be used for all BP measurements[18]	• Korotkoff phase V is detected with greater reliability than Korotkoff phase IV and is a better estimation of true diastolic pressure
Documentation	• Record site and position of the BP reading at the booking visit. • Be consistent at future antenatal visits	• Facilitates detection of true BP changes (i.e. not related to maternal position or site changes)

Appendix B: Maternal investigations

Investigation	Gestation (weeks)	Reference range*	Units	Description if preeclampsia
WBC	1-12	5.7-13.6	$x10^9$/L	**Higher** Largely due to exaggerated neutrophilia
	13-24	6.2-14.8		
	25-42	5.9-16.9		
	>42	5.7-16.9		
Hb	1-16	110-160	g/L	**Higher** Due to hemoconcentration unless there is microangiopathic haemolytic anaemia
	17-42	105-160		
Platelets	1-12	170-390	$x10^9$/L	**Lower** Less than 100 x 10^6/L may be associated with coagulation abnormalities[11]. Falling platelet count associated with worsening disease
	13-24	170-410		
	25-42	150-430		
	>42	150-430		
aPTT	0-42	26-41	seconds	**Higher** with DIC
INR	0-42	0.9-1.3		**Higher** with DIC
Fibrinogen	0-42	1.7-4.5	g/L	**Lower**
Glucose	0-42	3.0-7.8	mmol/L	**Low** in acute fatty liver of pregnancy
Serum Creatinine	0-42	32-73	mmol/L	**Higher** Due to hemoconcentration and/or renal failure.
Bilirubin (Total)	0-42	<20	µmol/L	**Higher** Unconjugated from hemolysis or conjugated from liver dysfunction
Albumin	0-26	35-50	g/L	**Lower**
	27-40	33-40		
AST	0-42	<31	U/L	**Higher**
ALT	0-42	<34	U/L	**Higher**
LDH	0-42	150-280	U/L	**Higher**
Proteinuria (24 hour)	0-42	<300	mg/24 hours	**Higher**
Random Protein: Creatinine ratio	0-42	<30	g/mol	**Higher**

*Reference ranges as per Pathology Queensland Central Laboratory

Appendix C: Hydralazine protocol

Hydralazine	
Indications	• Acute control of severe hypertension
Contraindications	• Known hypersensitivity • Systemic lupus erythematosus (SLE) • Severe tachycardia • Myocardial insufficiency • Right ventricular heart failure
Precautions	• Suspected/confirmed Coronary artery disease • Renal impairment • Hepatic impairment • Cerebrovascular disease
Route	• IV
Intermittent bolus	• 5-10 mg via slow injection • Repeated doses 5 mg IV 20 minutes apart if required (up to maximum 15 mg) • If maternal pulse greater than 130 beats/minute - cease • If 20 mg total given or longer term BP control required consider an infusion
Maintenance dose	• Commence at 2 mg/hour (IV via controlled infusion device) • Increase every 10 minutes by 2 mg/hour increments until BP stable • Maximum infusion rate 10 mg/hour • If maternal pulse greater than 125 beats/minute consider ceasing infusion
Side effects	• Tachycardia • Headache • Flushing • Palpitations
Monitoring during bolus doses	• Maintain systolic BP greater than 140 mmHg and diastolic greater than 90 mmHg • Monitor BP and pulse o every 5 minutes during administration and until stable, then o hourly for 4 hours • Continuous CTG
Monitoring during maintenance	• BP • Continuous CTG • FBC, LFT, coagulation profile, Group and hold • Strict fluid balance monitoring

Appendix D: Maintenance antihypertensive medications

Drug	Dose	Route	Action	Contraindications	Comments
Methyldopa[19,20]	250-750 mg tds	oral	Central		Maximum dose: 3 g daily Precaution: Depression may be exacerbated Side effects: sedation, dizziness, dry mouth, headache, weakness, gastrointestinal symptoms, depression
Labetalol[19,20]	100-400 mg tds	oral	Beta blocker with mild alpha vasodilator effect	Reversible airways disease (e.g. asthma)	Increase dosage gradually to minimise side effects Maximum dose: 2.4 g daily Side effects: postural hypotension, bradycardia, bronchospasm, headache, nausea,
*Oxprenolol[19,20]	20-160 mg bd	oral	Beta blocker	Bronchospasm	Maximum dose: 320 mg daily Side effects: cold extremities, sleep disturbances, tiredness, dizziness,gastrointestinal symptoms
Hydralazine[19,20]	25-50 mg bd	oral	Vasodilator	Systemic Lupus Erythemia and related diseases Avoid use before 3rd trimester	Maximum dose: 200 mg daily Side effects: tachycardia, palpitation, flushing, headache, lupus-like syndrome Test for acetylator phenotype for doses above 100mg daily
Nifedipine[19,20]	20 mg bd 20-120 mg SR daily	oral	Calcium channel blocker	Aortic stenosis	Maximum dose: 40 mg twice daily (conventional tablet) 120 mg daily (SR) Side effects: peripheral oedema, rash, fatigue, dizziness, flushing, nausea
Prazosin	0.5-5 mg tds	oral	Alpha blocker	Aortic stenosis	Maximum dose: 20 mg daily Side effects: postural hypotension, palpitations, nausea, dry mouth, weakness, headache, drowsiness
Clonidine	75-300 micrograms tds	oral	Central	Heart block	Maximum dose: 1.2 mg daily Side effects: drowsiness, dry mouth and gastrointestinal symptoms Withdrawal effect with clonidine

*Not on the QH List of Approved Medications (LAM)

Appendix E: Magnesium sulfate protocol

Facilities should develop local work instructions for the dilution and preparation of magnesium sulfate

Magnesium Sulfate	
Indications	• Preeclampsia with evidence of CNS dysfunction • Eclampsia (to stop or prevent further seizures)
Precautions	• Caution in women treated with calcium channel blockers, neuromuscular blockers, or with myasthenia gravis or heart block • Monitor serum Magnesium levels closely if renal function impaired (creatinine greater than 90 micromole/L or urine output less than 100 mL in 4 hours) o Therapeutic serum magnesium levels are 1.7-3.5 mmol/L • Enhances effect of central nervous system depressants
Route	• IV infusion via controlled infusion device
Loading dose	• 4 g bolus over 20 minutes
Persistent seizures	• Give a further 2 g bolus over 5 minutes • May be repeated in a further 2 minutes if seizures persist
Maintenance dose	• 1 g/hour for 24 hours after birth then review for continuation/cessation • If impaired renal function: o reduce maintenance dose to 0.5 g/hour o discuss serum monitoring requirements with an obstetrician • Facilities should develop dilution/preparation protocols for magnesium sulfate if not using standard pre-mix preparations
Side effects	• Hypotension secondary to reduction in systemic vascular resistance • Nausea and vomiting • Flushing • Thirst • Weakness • Reduced fetal heart rate variability
Midwifery Care	• One to one midwifery care in birth suite or high dependency unit for the duration of therapy
Monitoring during loading dose	• BP and pulse every 5 minutes until stable (minimum x 4 readings) • Observe for side effects • Check deep tendon reflexes after completion of loading dose (patellar or biceps if epidural insitu) o Notify obstetrician if absent
Monitoring during maintenance infusion	• BP, pulse and respiratory rate (RR) ½ hourly • Deep tendon reflexes hourly (patellar or biceps if epidural insitu). o Record as: A=Absent, N=Normal, B=Brisk • Temperature 2 hourly • Continuous CTG monitoring from 26 weeks gestation • Strict fluid balance monitoring and documentation o Notify obstetrician if urine output less than 25-30 mL/hour o Indwelling urinary catheter is recommended • Serum monitoring is not required if renal function normal
Symptoms of overdose	• Absent deep tendon reflexes • Slurred speech • Respiratory depression/difficulty (RR less than 12/minute) • Cardiac arrest
Management of overdose	• Cease magnesium infusion • Call for help and initiate resuscitation measures as required • Notify obstetrician immediately • Give calcium gluconate 10 mL 10% solution (1 g) IV injection over 5 minutes to reverse respiratory depression and heart block • ECG to identify heart block
Discontinuation	• Before discontinuing therapy o BP should be stable (consistently less than 150/100 mmHg) o Clinical improvement should be evident (absence of headache, epigastric pain)

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