Queensland Clinical Guidelines

Translating evidence into best clinical practice

Maternity and Neonatal **Clinical Guideline**

Hypertension and pregnancy

Queensland Government

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Cultural acknowledgement

We acknowledge the Traditional Custodians of the land on which we work and pay our respect to the Aboriginal and Torres Strait Islander Elders past, present and emerging.

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Flow Chart: Management of hypertension in pregnancy

Risk factors for pre-eclampsia
- Previous history of pre-eclampsia
- Family history of pre-eclampsia
- Inter-pregnancy interval ≥ 10 years
- Nulliparity and/or multiple pregnancy
- Pre-existing medical conditions
  - Congenital heart defects
  - Pre-existing diabetes
  - Renal disease
  - Chronic hypertension
  - Chronic autoimmune disease
- Age ≥ 40 years
- BMI ≥ 30 kg/m^2
- Maternal depression or anxiety
- Assisted reproductive technology
- Gestational trophoblastic disease
- Fetal triploidy

Indications to consider birth
- Non-reassuring fetal status
- Severe fetal growth restriction
- Uncontrollable pre-eclampsia
- Eclampsia
- Uncontrollable hypertension
- Placental abruption
- Acute pulmonary oedema
- Deteriorating platelet count, liver and/or renal function
- Persistent neurological symptoms
- Persistent epigastric pain, nausea or vomiting with abnormal liver function tests

Severe hypertension/pre-eclampsia
- Multidisciplinary team approach
- Manage in birth suite/HDU
- Strict control of BP
- Maternal and fetal assessments
- Continuous #CTG
- Consider magnesium sulfate
- Consider corticosteroids if preterm labour anticipated
- Strict fluid management
- FBC, ELFT including urate & LDH
- Coagulations screen
- Urine for protein to creatinine ratio
- Consider transfer to higher level facility, if required

Stabilise prior to birth
- Control hypertension
- Correct coagulopathy
- Consider eclampsia prophylaxis
- Attention to fluid status

Postpartum
- Close clinical surveillance for postpartum hypertension
- Consider VTE prophylaxis
- Consider timing of discharge
- Arrange follow up
- Maternal screening as indicated

Hypertension sBP ≥ 140 mmHg and/or dBP ≥ 90 mmHg

↓

Maternal investigations and fetal assessment

↓

Is birth indicated?

Yes → **Birth**

No ↓

Inpatient or outpatient care

↓

Worsening maternal or fetal condition?

No → back to **Is birth indicated?**

Yes → **Birth**

Maternal investigations
- Urine dipstick for proteinuria
- Spot urine protein to creatinine ratio if:
  - ≥ 2+ or recurrent 1+ on dipstick
- Full blood count
- Urea, creatinine electrolytes and urate
- LFT including LDH

Fetal assessment
- #CTG
- USS for fetal growth & wellbeing

Initiate antihypertensives

Commence if:
- sBP ≥ 160 or dBP ≥ 110 mmHg

Consider if:
- sBP ≥ 140 or dBP ≥ 90 mmHg
- Choice of antihypertensive drug as per local preferences/protocols

Oral antihypertensive (initial dose – adjust as clinically indicated)
- Methyldopa 125–250 mg bd
- Labetalol 100 mg bd
- Nifedipine (SR) 20–30 mg daily
- Hydralazine 25 mg bd
- ^Nifedipine (IR) 10–20 mg bd
- Prazosin 0.5 mg bd
- Clonidine 50–100 micrograms bd

Outpatient care
- If mild-moderate hypertension without preeclampsia
- Individualise of appointments

Consider admission if:
- Fetal wellbeing is of concern
- sBP ≥ 140 mmHg or
- dBP ≥ 90 mmHg or
- Symptoms of pre-eclampsia, or proteinuria or pathology results abnormal

Inpatient monitoring
- BP 4 hourly if stable
- #CTG daily
- Ward urinalysis, as required
- Maintain accurate fluid balance
- Daily review (minimum) by obstetrician
- Normal diet
- Bedrest is not usually recommended
- Consider VTE prophylaxis

ALPS: antiphospholipid syndrome, BMI: body mass index, BP: blood pressure, CTG: cardiotocograph, dBP: diastolic BP, ELFT: electrolytes and liver function test, FBC: full blood count, FHR: fetal heart rate, HDU: high dependence unit, LDH: Lactate dehydrogenase, sBP: systolic BP, USS: ultrasound scan, VTE: venous thromboembolism, >: greater than, <: less than, ≥: greater than or equal to, ≤: less than or equal to, ^Nifedipine formulations available with SAS authority, #interpret CTG with caution when gestational age less than 28 weeks

Flowchart: F21.13-2-V9-R26

Flow Chart: Management of eclampsia

Resuscitate

Follow resuscitation principles
- **D** – Dangers
- **R** – Response
- **S** – Send for Help
- **A** – Airway
- **B** – Breathing
- **C** – Compressions
- **D** – Defibrillation

Control seizures

Loading dose magnesium sulfate
- 4 g IV over 20 minutes via controlled infusion device

If seizures occur/ongoing while preparing magnesium sulfate
- Diazepam 5–10 mg IV at a rate of 2–5 mg/ minute (maximum dose of 10 mg) OR
- Clonazepam 1–2 mg IV over 2–5 minutes OR
- Midazolam 5–10 mg IV over 2–5 minutes or IM

Maintenance dose magnesium sulfate
- 1 g per hour IV via controlled infusion device for 24 hours after birth
- Then review requirement

If seizures reoccur while receiving magnesium sulfate
- Magnesium sulfate 2 g IV over 5 minutes
  - o May be repeated after 2 minutes
- Diazepam 5–10 mg IV at a rate of 2–5 mg/ minute (maximum dose of 10 mg) OR
- Midazolam 5–10 mg IV over 2–5 minutes or IM OR
- Clonazepam 1–2 mg IV over 2–5 minutes

If impaired renal function
- Reduce maintenance dose of magnesium sulfate to 0.5 g/hour
- Ongoing serum monitoring

Monitor
- BP and pulse every 5 minutes until stable then every 30 minutes
- Respiratory rate and patellar reflexes hourly
- Temperature 2nd hourly
- Continuous ^CTG monitoring
- Measure urine output hourly via IDC
- Strict fluid balance monitoring
- Check serum magnesium if toxicity is clinically suspected
- Therapeutic serum magnesium level 1.7–3.5 mmol/L

Stop infusion
- Review management with consultant if:
  - o Urine output < 80 mL in 4 hours
  - o Deep tendon reflexes are absent or
  - o Respiratory rate < 12 breaths/minute

Antidote
- 10% calcium gluconate 10 mL IV over 5 minutes

Control hypertension

Treat hypertension
- If: sBP ≥ 160 mmHg or dBP ≥ 110 mmHg
- Aim to reduce sBP to 130–150 mmHg and dBP to 80–90 mmHg
- Avoid maternal hypotension
- Monitor FHR with continuous ^CTG
- Choice of antihypertensive drug as per local preferences/protocols

#Nifedipine
- 10–20 mg immediate release tablet oral, repeat after 45 minutes
- Maximum dose 80 mg

Hydralazine
- 5–10 mg IV over 3–10 minutes
- Repeated doses 5 mg IV every 20 minutes if required
- Maximum dose 30 mg
- Infusion may be required
- May require plasma expansion

#Labetalol
- Initially 20 mg IV bolus over 2 minutes
- Repeated doses 40–80 mg IV every 10 minutes to maximum of 300 mg if required
- Infusion may be required

#Diazoxide
- 15–45 mg IV rapid bolus
- Repeat after 5 minutes if required
- Maximum 150 mg/dose
- Monitor BGL

If antepartum, plan birth asap

Birth
- Plan birth as soon as feasible using a multidisciplinary approach
- Mode of delivery based on maternal and fetal wellbeing
- Continue close fetal monitoring
- Stabilise the woman prior to birth
- Actively manage third stage
- Ergometrine should NOT be used in severe preeclampsia or eclampsia
- Consider *carbetocin if increased risk of PPH
- Consider VTE prophylaxis

Investigations
- Full blood count and platelets
- Urea and electrolytes
- Liver function tests/LDH
- Coagulation screen
- Group and hold serum

ASAP: as soon as possible **BGL:** blood glucose level **BP:** blood pressure, **CTG: c**ardiotocograph, **dBP:** diastolic BP, **FHR:** fetal heart rate, **IDC:** indwelling catheter, **IV:** intravenous, **LDH:** lactate dehydrogenase, **PPH:** primary postpartum haemorrhage **sBP:** systolic BP, **VTE:** venous thromboembolism, **>:** greater than, **<:** less than, **≥:** greater than or equal to, **≤:** less than or equal to, **#:** Special Access Scheme (SAS) authority required, * not on Queensland Health List of approved medicines, **^**interpret CTG with caution when gestational age less than 28 weeks

Adapted from: Algorithm 16.1 Preeclampsia/eclampsia *in* The Moet course manual: managing obstetric emergencies and trauma (2007)

Flowchart: F21.13-1-V8-R26

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Abbreviations

ACE	Angiotensin converting enzyme
AC	Abdominal circumference
AEDF	Absent end-diastolic flow
AFI	Amniotic fluid index
APLS	Antiphospholipid syndrome
BMI	Body mass index
BP	Blood pressure
CI	Confidence interval
CTG	Cardiotocograph
dBP	Diastolic blood pressure
DIC	Disseminated intravascular coagulation
DVP	Deepest vertical pocket
EFW	Estimated fetal weight
FBC	Full blood count
FGR	Fetal growth restriction
FHR	Fetal heart rate
GA	General anaesthesia
HDP	Hypertensive disorders of pregnancy
GP	General practitioner
HELLP	**H**aemolysis, **E**levated **L**iver enzymes and **L**ow **P**latelet count
IUGR	Intrauterine growth restriction
LAM	List of approved medicines
LDH	Lactate dehydrogenase
LFT	Liver function test
MAP	Mean arterial pressure
PAPP-A	Pregnancy associated plasma protein A
PlGF	Placental growth factor
sBP	Systolic blood pressure
SLE	Systemic lupus erythematosus
sFlt-1	Soluble fms-like tyrosine kinase 1
RR	Relative risk
SpO_2	Saturation of peripheral oxygen
UA	Umbilical artery
USS	Ultrasound scan
UTPI	Uterine artery pulsatility index
VTE	Venous thromboembolism

Definitions

Expectant management	Refers to safe prolongation of the pregnancy, with maternal and fetal monitoring guiding clinically indicated treatment, instead of immediate birth.
Multidisciplinary team	May include (as relevant to the clinical circumstances) obstetrician, midwife, obstetric physician, anaesthetist, neonatologist/paediatrician experienced in the care of women with hypertension in pregnancy.
Obstetrician	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.
Korotkoff sounds	Refers to the audible noises used to measure blood pressure and can be broken down into five phases[1]: • Phase I is a clear tapping tone • Phase II is a softening of the tapping and a swishing element • Phase III sounds like phase I but with distinct sharpening • Phase IV has abrupt muffling of all sounds • Phase V is a cessation of all sounds
Mean arterial pressure (MAP)	• MAP is calculated by using a validated blood pressure machine or by[2]: o The sum of sBP plus twice the dBP divided by 3 o $(sBP + 2\ X\ dBP) \div 3$

1 Introduction

Hypertension is the most common medical problem encountered in pregnancy and is a leading cause of perinatal and maternal morbidity and mortality worldwide.[3]

Table 1. Prevalence in Australia

Aspect	Consideration
Maternal complications	• In Queensland between 2014–2019 there were 364,194 pregnancies where:[4] o Gestational hypertension affected 9,692 women o Pre-eclampsia affected 8,463 women o Eclampsia affected 139 women
Perinatal deaths	• In Australia in 2017, there were 36 total perinatal deaths where a hypertensive disorder, such as pre-eclampsia or pre-existing high blood pressure, was considered to have been the leading cause of the death[5]

Adapted from: Department of Health Queensland. Hypertensive disorders of pregnancy data 2014–2019. Perinatal Data Collection, Health Statistics Branch. 2020.

2 Definition

The following definitions of hypertension in pregnancy are used in this guideline.

Table 2. Definitions of hypertension

Aspect	Consideration
Mild to moderate hypertension[6]	• Blood pressure (BP) measured at least four hours apart with elevation occurring at least twice[7] o Systolic blood pressure (sBP) greater than or equal to 140 mmHg (but less than 160 mmHg) ***and/or*** o Diastolic blood pressure (dBP) greater than or equal to 90 mmHg (but less than 110 mmHg)
Severe hypertension[6]	• sBP greater than or equal to 160 mmHg ***and/or*** • dBP greater than or equal to 110 mmHg • sBP greater than or equal to 170 mmHg with or without dBP greater than or equal to 110 mmHg is a medical emergency and requires urgent treatment

3 Classification

The following classifications of hypertension in pregnancy are used in this guideline.

3.1 Confirmed before pregnancy or before 20 weeks gestation

Table 3. Hypertension diagnosed prior to pregnancy or in the first 20 weeks gestation

Aspect	Consideration
Chronic hypertension occurring in pregnancy (Essential and secondary)[8]	• Hypertension confirmed prior to conception ***or*** prior to 20+0 weeks • May include women entering pregnancy on antihypertensive therapy with well controlled hypertension • Can be defined as: o Essential hypertension (no secondary cause determined) o Secondary hypertension where causes may include[9,10]: ▪ Renal parenchymal 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 (SLE)) ▪ Endocrine disorders (e.g. phaeochromocytoma, Cushing's syndrome, primary hyperaldosteronism, hyper- or hypothyroidism and acromegaly) ▪ Coarctation of the aorta ▪ Obstructive sleep apnoea ▪ Medications or supplements (e.g. oral contraceptives, nonsteroidal anti-inflammatory drugs, corticosteroids, cocaine, stimulants, antipsychotic medications[11])
White coat hypertension[8]	• Hypertension characterised by an elevated BP in a clinical setting and a normal BP at other times • Typically diagnosed by 24 hour ambulatory BP monitoring or home BP monitoring using an appropriately validated device • Women with white coat hypertension are at an increased risk of developing pre-eclampsia compared with normotensive women (RR 2.36, 95% CI, 1.16 to 4.78)[12]
Masked hypertension[8]	• Hypertension characterised by a normal BP in a clinical setting and an elevated BP at other times • Typically diagnosed by 24 hour ambulatory BP monitoring or home BP monitoring using an appropriately validated device[8]

3.2 Arising de novo at or after 20 weeks gestation

Table 4. Hypertension arising de novo at or after 20 weeks gestation

Aspect	Consideration
Transient gestational hypertension[8]	• Hypertension that: o Arises in the second and third trimester o Is detected in the clinical setting but settles after repeated readings (e.g. those taken over the course of several hours in a day assessment unit[8]) • Associated with a 40% risk of developing gestational hypertension or pre-eclampsia in the remainder of the pregnancy[13]
Gestational hypertension[8]	• New onset of hypertension arising after 20 weeks gestation • No additional features of pre-eclampsia • Resolves within 3 months postpartum
Pre-eclampsia[8]	• A multi-system disorder characterised by hypertension, and involvement of one or more other organ systems and/or the fetus • Resolves within 3 months postpartum
Pre-eclampsia superimposed on chronic hypertension[8]	• New onset systemic features of pre-eclampsia after 20+0 weeks gestation to women with pre-existing hypertension

3.3 Diagnosis of pre-eclampsia

A diagnosis of pre-eclampsia requires both[6]:

- Hypertension arising after 20+0 weeks gestation, confirmed on 2 or more occasions AND
- ***One or more*** of the organ/system features related to the mother and/or fetus identified in Table 5. Diagnosis of pre-eclampsia.

Note:

- Hypertension may not be the first manifestation
- Pre-existing hypertension is a strong risk factor for the development of pre-eclampsia[6] and requires close clinical surveillance
- Proteinuria is common but is not mandatory to make the clinical diagnosis[6,8]

Table 5. Diagnosis of pre-eclampsia

Aspect	Consideration
Renal	• Random urine protein to creatinine ratio greater than or equal to 30 mg/mmol[14] from an uncontaminated specimen (proteinuria) • Serum or plasma creatinine greater than or equal to 90 micromol/L[14] ***or*** • Oliguria (less than 80 mL/4hours or 500 mL/24 hours)
Haematological	• Thrombocytopenia[14] (platelets under 150 x 10^9/L) • Haemolysis[8] (schistocytes or red cell fragments on blood film, raised bilirubin, raised lactate dehydrogenase (LDH), decreased haptoglobin) • Disseminated intravascular coagulation (DIC)[8]
Liver	• New onset of raised transaminases[14] (over 40 IU/L) with or without epigastric or right upper quadrant pain[8,15]
Neurological	• Headache[8] • Persistent visual disturbances (photopsia, scotomata, cortical blindness, retinal vasospasm) • Hyperreflexia with sustained clonus • Convulsions (eclampsia) • Stroke
Pulmonary	• Pulmonary oedema[14]
Uteroplacental	• Fetal growth restriction (FGR)[8] • Suspected fetal compromise[14] • Abnormal umbilical artery Doppler wave form analysis • Stillbirth

3.4 Initial investigations for new onset hypertension after 20 weeks

Where it is not possible to adequately undertake comprehensive fetal and maternal assessments the baseline investigations may consist of blood pressure measurement **and** maternal risk factors.[15]

Table 6. Initial investigations

Aspect	Consideration
BP measurement	• Correct measurement techniques are critical to the correct diagnosis of HDP[16] • Confirm non-severe hypertension by measuring BP over several hours o Up to 70% of women with an office BP of 140/90 mmHg have normal BP on subsequent measurements on the same visit[17] • Refer Appendix A: Blood pressure measurement
Proteinuria	• Screen for proteinuria with urinary dipstick at first visit and at each subsequent visit[17] • Quantify by laboratory methods if: o Greater than or equal to 2+ proteinuria ***or*** o Persistent 1+ proteinuria ***or*** o Pre-eclampsia is suspected • In an uncontaminated sample, a urine protein to creatinine ratio greater than 30 mg/mmol is diagnostic of proteinuria in pregnancy[6,8,14] • 24 hour urine collection is not necessary in routine clinical management • Proteinuria testing does not need to be repeated once significant proteinuria in the setting of confirmed pre-eclampsia has been detected
Pre-eclampsia baseline blood tests	• Recommended baseline blood tests: o Full blood count (FBC)[8] o Urea, creatinine, electrolytes and urate[8] o Liver function tests (LFT) including LDH[8] • Tests may be abnormal even when BP elevation is minimal
Additional pre-eclampsia investigations	• If there is thrombocytopenia or a substantial fall in haemoglobin, perform investigations for DIC and/or haemolysis including[8]: o Coagulation studies o Blood film o Fibrinogen o Haemolytic studies • Refer to Table 24. Maternal and fetal surveillance • If severe or early signs of pre-eclampsia, consider investigation for associated conditions (e.g. antiphospholipid syndrome (APLS), chronic renal disease)[18] • Urinalysis and microscopy on a carefully collected mid-stream urine sample (to avoid contamination)[6]
Fetal assessment	• Cardiotocograph (CTG) if greater than 28+0 weeks gestation[8] o Consider fetal physiology and use caution when interpreting CTGs at less than 28+0 weeks gestation o Refer to Queensland Clinical Guideline *Perinatal care of the extremely preterm baby*[19] • Ultrasound scan (USS) assessment of[8,18]: o Fetal growth o Amniotic fluid volume (AFV) or deepest vertical pocket (DVP) o Umbilical artery flow (Doppler) • Further follow-up USS to assess fetal growth velocity and progression of Doppler changes

4 Risk assessment

Assess women presenting with new hypertension after 20 weeks gestation for signs and symptoms of pre-eclampsia[18] [refer to Section 3.4 Initial investigations for new onset hypertension after 20 weeks]. The earlier the gestation at presentation and the more severe the hypertension, the higher the likelihood that the woman will progress to develop pre-eclampsia or an adverse pregnancy outcome.[6]

4.1 Risk factors for pre-eclampsia

The risk of pre-eclampsia for an individual woman has been associated with the presence or absence of clinical, sonographic and biochemical markers. However, there is currently no adequate predictive tool or marker that can be used in isolation.[6]

The presence of multiple risk factors may have additive or synergistic effects, but the combinations with the greatest risk are uncertain.

Table 7. Clinical risk factors for pre-eclampsia

Risk factor	Relative risk [95% CI]
Previous history of pre-eclampsia[20]	8.40 [7.10 to 9.90]
*Adolescent pregnancy (10–19 years)[21]	6.70 [5.80 to 7.60]
Systemic lupus erythematosus[22]	5.50 [4.50 to 6.80]
Chronic hypertension[20]	5.10 [4.00 to 6.50]
Assisted reproductive technology (donor oocytes)[20]	4.34 [3.10 to 6.06]
Pre-existing diabetes[20]	3.70 [3.10 to 4.30]
Family history of pre-eclampsia[23]	2.90 [1.70 to 4.93]
Twin pregnancy (increased risk with multiples)[24]	2.93 [2.04 to 4.21]
Body mass index (BMI) before pregnancy (> 30 kg/m^2)[20]	2.80 [2.60 to 3.60]
Antiphospholipid syndrome[20]	2.80 [1.80 to 4.30]
Nulliparity[20]	2.10 [1.90 to 2.40]
Pre-existing kidney disease[20]	1.80 [1.50 to 2.10]
Assisted reproductive technology (donor sperm)[20]	1.63 [1.36 to 1.95]
Maternal congenital heart defects[25]	1.50 [1.30 to 1.70]
Maternal anxiety or depression[26]	1.27 [1.07 to 1.50]
Inter-pregnancy interval greater than 10 years[20]	1.10 [1.02 to 1.19]
Gestational trophoblastic disease[27]	Unavailable
Fetal triploidy[28]	Unavailable
Fetal aneuploidy[2]	Unavailable

*Limited data (primarily from low resourced countries) may suggest higher incidence in adolescent pregnancies

4.2 Screening for pre-eclampsia risk

No single test can reliably predict the risk of pre-eclampsia; however, a combination of maternal and fetal parameters may detect a higher risk of pre-eclampsia.[8,15] While screening for pre-eclampsia risk can occur at any time during the pregnancy, typically it is considered in the first trimester (to allow intervention to reduce future risk) and in the second/third trimester (for short term likelihood and timing of onset of preeclampsia).

4.2.1 First trimester screening methods for pre-eclampsia detection

Utilising a combinations of screening tests, compared to maternal factors alone, may assist in higher prediction rates for **early onset** of pre-eclampsia in high risk women.

Table 8. First trimester screening methods

Aspect	Consideration
Context	• The risk of future development of pre-eclampsia can be established in the first trimester using a combination of maternal history, [refer to 4.1 Risk factors for pre-eclampsia] mean arterial pressure (MAP), sonographic and biochemical markers[15] • Early screening for risk of pre-eclampsia may contribute to early risk reduction interventions including commencement of aspirin in high risk women and increased monitoring[30,31] [Refer to section 4.3 Risk reduction] • After maternal history, each additional screening test has been demonstrated to increase the overall accuracy of prediction of pre-eclampsia [refer to Table 9. Comparison of first trimester screening methods] • Screening tests are available across Queensland, however routine use in all women is not recommended[29] o Develop local protocols for recognition and targeted screening of women at higher risk of pre-eclampsia
Maternal arterial pressure	• MAP has been demonstrated to be more predictive of pre-eclampsia among low risk women than either sBP or dBP readings alone[2] • Blood pressure measured in both arms simultaneously, with the average of four calculated MAP measurements, may assist with risk stratification for pre-eclampsia development[32] [Refer to definitions]
First trimester risk screening	• In addition to maternal history, clinical risk and MAP, consider additional testing if clinically indicated[15,33]: o Placental growth factor (PlGF) ▪ Lowered levels in women at risk of pre-eclampsia[15] and in fetal aneuploidies and/or impaired placentation[2] disorders (which can also be associated with pre-eclampsia) ▪ Positive predictive detection value of 56%[15] for pre-eclampsia o Uterine artery pulsatility index (UTPI) ▪ Measured between 11+0 and 13+6 weeks gestation[15] ▪ Positive predictive detection value of 48% for early onset pre-eclampsia o Pregnancy associated plasma protein A (PAPP-A) ▪ Levels less than 0.4 MoM, associated with an increased risk of HDP, preterm birth and fetal growth restriction[34] ▪ Present in 8–23% of women with pre-eclampsia[15] ▪ Low positive predictive detection value of 16%[15]

4.2.2 Comparison of first trimester screening methods

If one or more specific biomarkers are combined, there are incremental benefits including increases in detection rates of pre-eclampsia.[30]

Table 9. Detection rates for preterm pre-eclampsia by screening method

Baseline method	Detection rate (%)	Add to baseline method	Final detection rate (%)	Additional cases detected (%) 95% CI
MF alone	41.55	+ MAP	49.30	7.75 (1.60 to 14.60)
		+ UTPI	61.97	20.42 (12.9 to 28.5)
		+ PlGF	59.15	17.61 (10.1 to 25.7)
		+ PAPP-A*	45.07	3.52 (-1.70 to 9.20)
MF + MAP	49.30	+ PlGF	68.31	19.01 (11.7 to 27.0)
		+ UTPI	73.94	24.65 (16.7 to 33.0)
MF + MAP + UTPI	73.94	+ PLGF	81.69	7.75 (2.30 to 14.10)
MF + MAP + PlGF	68.31	+ UTPI	81.69	13.38 (8.00 to 20.2)
MF + UTPI + PlGF	70.42	+ MAP	81.69	11.27 (5.30 to 18.2)

MAP: mean arterial pressure, MF: maternal factors, PAPP-A: pregnancy-associated plasma protein-A, PlGF: placental growth factor, UTPI: uterine artery pulsatility index, values in parentheses are 95% confidence interval (CI)
#Preterm pre-eclampsia defined as detection at less than 37 weeks gestation
*Note: results not significant for increase in detection rates

4.2.3 Second and third trimester screening methods

Table 10. Second and third trimester screening methods

Aspect	Consideration
Context	• In second and third trimester, use of the sFlt-1/PlGF ratio can aid prediction of short-term likelihood and timing of onset of pre-eclampsia in high risk women[15,33] • While not part of the definition of pre-eclampsia, women with a rise in BP of greater than sBP 30 mmHg and dBP 15 mmHg from their booking or preconception BP may be at risk of pre-eclampsia, particularly in the presence of other clinical features[6]
sFlt-1/PlGF ratio for prediction of pre-eclampsia	• Predicts the short term likelihood and timing of onset of pre-eclampsia[15,33] o The sFlt-1/PlGF ratio performs better than single markers[15,33] o Up to five weeks before the onset of clinical symptoms of pre-eclampsia, serum concentrations of soluble fms-like tyrosine kinase 1 (sFlt-1) are increased and PlGF concentrations are decreased resulting in an increased sFlt-1/PlGF ratio • Consider use (where available and practicable): o After 20 weeks gestation in high risk women with symptoms and signs suspicious, but not diagnostic of pre-eclampsia (including those that may mimic pre-eclampsia, such as SLE) • Refer to Table 11. sFlt-1/PlGF ratio threshold cut off points

4.2.4 sFlt-1/PlGF ratio threshold cut off points

Table 11. sFlt-1/PlGF ratio threshold cut off points

Gestation	Level*	Consideration
20+0 to term	Less than, or equal to 38	• Indicates a high negative predictive value of 99.3% to exclude current diagnosis of, or development of pre-eclampsia within seven days in singleton pregnancies[26]
20+0 to 33+6	Greater than, or equal to 38	• Indicates a low positive predictive value of 36.7% for pre-eclampsia development within four weeks in singleton pregnancies[35]
	Greater than, or equal to 85	• Indicates a high likelihood of having preeclampsia (sensitivity/specificity 88%/99.5%)[36] • This threshold predicts the occurrence of pre-eclampsia related adverse maternal and fetal outcomes[33,35,37]
34+0 to term	Greater than, or equal to 110	• Indicates a high likelihood of having pre-eclampsia (sensitivity/specificity 58.2%/95.5%)

*Ratio cut off points may be influenced by individual pathology providers and manufacturer recommendations

4.3 Risk reduction

While no single treatment reliably prevents pre-eclampsia[8], a number of interventions have been shown to reduce risk in specific populations.

Table 12. Risk reduction

Aspect	Consideration
Assessment	• Assess for risk factors and consider risk reduction strategies, including antiplatelet agents[8] o Refer to 4.1. Risk factors for pre-eclampsia
Aspirin	• Women treated with antiplatelet agents demonstrated a reduction in[38,39]: o Pre-eclampsia by 18% (RR 0.82 [95% CI 0.77 to 0.88]) o Small for gestational age newborns (RR 0.84 [95% CI 0.76 to 0.92]) o Preterm birth less than 37 weeks by 9% (RR 0.91 [95% CI 0.87 to 0.95]) o Perinatal mortality by 14% (RR 0.85 [95% CI 0.76 to 0.95]) • The number needed to treat (NNT) to prevent one diagnosis of pre-eclampsia is 61 [95% CI 45 to 92][39] • Advise women at moderate to high risk of pre-eclampsia to commence aspirin: o 100–150 mg daily o Preferably at night[15,40], o Ideally before 16+0 weeks[41] gestation • Women treated with aspirin may be at a slightly increased risk of postpartum haemorrhage (RR 1.25 [95% CI 0.84 to 1.86])[38] o Consider discontinuing aspirin at 36+0 weeks gestation[42] based on evaluation of individual risk
Heparin	• Insufficient evidence to support routine use in the prevention of pre-eclampsia (other than in the specific case of APLS)[8]
Calcium	• May reduce the risk of pre-eclampsia in high risk women where there is deficient calcium intake (less than 600 mg/day)[8,43]: o Recommend 1.2–2.5 g/day[8] • Recommend in addition to aspirin • Insufficient evidence to recommend routine use for all women[14,20]
Advice if high risk of pre-eclampsia	• Advise women at high risk of HDP of the symptoms of pre-eclampsia o If symptoms develop, to seek immediate advice from a health care professional o Refer to Queensland Clinical Guidelines Consumer Information: *High Blood Pressure (hypertension) in Pregnancy* • Symptoms include[14,18]: o Severe headache o Problems with vision (e.g. blurring or flashing before the eyes) o Severe upper abdominal pain o Vomiting o Sudden or progressive peripheral oedema
Therapies unsupported by evidence	• There is insufficient evidence to support routine use (for prevention or risk reduction of hypertensive disorders of pregnancy) of: o Magnesium supplementation[44] o Zinc supplementation[45] o Bed rest[14] o Dietary salt restriction[17] o Antioxidants

4.4 Perinatal adverse outcomes associated with hypertensive disorders

Table 13. Adverse perinatal outcomes associated with hypertensive disorders

Aspect	Consideration
Short term outcomes	• Short term outcomes may include: o Prematurity o Small for gestational age[46] o Admission to intensive care nursery[15] o Stillbirth/death
Long term outcomes	• Longer term outcomes may include[15]: o Insulin resistance o Diabetes mellitus o Coronary artery disease o Hypertension o Increased cardiovascular risks o Overweight or obesity

4.5 Adverse maternal outcomes associated with hypertensive disorders

HDP have been associated with a number of adverse outcomes for women.[6,47] These may also contribute to long term cardiovascular risk[48] and have, on average, demonstrated a reduction in life expectancy of ten years.[10] Consider the entire clinical picture of pre-existing conditions, and potential long term effects from HDP when planning for long term cardiovascular disease surveillance and targeted intervention.

Table 14. Adverse maternal outcomes associated with hypertensive disorders

If pregnancy complicated by[6]:	**Recurrence risk in future pregnancy of**	
	Gestational hypertension	*Pre-eclampsia*
• Gestational hypertension	16–47%	2–7%
• Pre-eclampsia	13–53%	16%
• Severe pre-eclampsia o Less than 34 weeks o Less than 28 weeks		 25% 55%
After pre-eclampsia, relative risk of[49-51]:	**Relative risk [95% CI]**	
• End stage renal disease	4.70 [3.60 to 6.10]	
• Heart failure	4.19 [2.09 to 8.38]	
• Cerebrovascular disease/stroke	2.50 [1.43 to 3.47]	
• Chronic hypertension	2.20 [2.10 to 2.30]	
• Deep vein thrombosis	2.10 [1.80 to 2.40]	
• Type II diabetes	1.80 [1.60 to 1.90]	
• Hypercholesterolaemia	1.30 [1.30 to 1.40]	
Other reported sequelae		
• Cerebral injury: o Cerebral perfusion pressure is altered in pregnant women making them more susceptible to cerebral haemorrhage, posterior reversible encephalopathy syndrome and hypertensive encephalopathy[6] o sBP as opposed to dBP, or relative increase or rate of increase of mean arterial pressure from baseline levels, may be the most important predictors of cerebral injury and infarction[52] • Mortality: o Hypertensive disorders of pregnancy were the cause of six maternal deaths between 2015–17 in the MBRRACE-UK report[53,54] of which three were directly attributed to cerebral events[54] • Higher risk of developing placental abruption[46], DIC, hepatic failure and acute renal failure[6] • If severe pre-eclampsia/eclampsia: o Impaired cognitive function and memory at three to eight months postpartum unrelated to scores of depression, anxiety or attention • If eclampsia: o Increased self-reporting of cognitive failures and impaired vision several years after pregnancy compared to women with normal BP or women with pre-eclampsia		

5 Treatment of hypertension

There is no clear evidence to recommend one antihypertensive drug therapy over another.[55] Familiarity and experience with the chosen agent is the most important consideration.[6] Develop local protocols for administration and use. The goals of antenatal care in the presence of hypertension include BP control, early recognition of pre-eclampsia, delayed progression to more severe disease and optimised birth for both the woman and her baby[55] [refer to Section 9 Birth].

5.1 Mild to moderate hypertension

Table 15. Mild to moderate hypertension

Aspect	Consideration
Context	• Antihypertensive therapy halves the risk of developing severe hypertension (20 trials, 2558 women; RR 0.49; 95%,CI 0.40 to 0.60) but has no clear effect on other outcomes (e.g. pre-eclampsia, perinatal mortality)[55] • Concerns exist about the potential for decreased placental perfusion from aggressive BP lowering that might jeopardise fetal wellbeing[8]
Indication for drug therapy	• Consider drug therapy if:[8]: o sBP is persistently greater than 140 mmHg ***and/or*** o dBP is persistently greater than 90 mmHg o There are associated signs and symptoms of pre-eclampsia • Recommend drug therapy if blood pressure greater than 160/110 mmHg o Refer to section 5.3 Severe hypertension
Target BP	• There is no clear evidence about the optimal target BP for mild to moderate hypertension in pregnancy[56] • Lower end targets *may be* appropriate if there are co-morbidities[56] • Consider individual circumstances • Suggested targets[8]: o sBP 110–140 mmHg o dBP 85 mmHg

5.2 Oral antihypertensive drug therapy

Antihypertensive drug therapy for elevated blood pressure in pregnancy reduces the risk of the development of severe hypertension.[55] Refer to an Australian pharmacopeia, such as the Australian Medicines Handbook, for full details of all drugs. Angiotensin converting enzyme (ACE) inhibitors and angiotensin receptor blockers are contraindicated in pregnancy.

Table 16. Oral antihypertensive drug therapy

Drug	Initial dose	Maintenance Dose	Maximum daily dose
Methyldopa[57]	125–250 mg BD	250–500 mg 2–4 times daily	Maximum/day 2 g
Labetalol[58]	100 mg BD	200–400 mg 2–4 times daily	Maximum daily dose: 2.4 g
Hydralazine[59,60]	25 mg BD	25–100 mg BD	Maximum daily dose: 200 mg
Nifedipine (SR)[61,62]	20–30 mg daily	60–120 mg daily	Maximum daily dose: 120 mg
[#]Nifedipine (IR)[61,63]	10–20 mg BD	20–40 mg BD	Maximum daily dose: 80 mg
Prazosin[64]	0.5 mg BD	1 mg TDS	Maximum daily dose: 20 mg
Clonidine[65,66]	50–100 microgram BD	150–300 microgram BD	Maximum daily dose: 600 microgram

[#]Special Access Scheme (SAS) authority required. Note: Nifedipine formulations available with SAS authority

5.3 Severe hypertension

Severe hypertension is a medical emergency and requires immediate assessment with prompt treatment. Pregnant women with hypertension may not appear ill, which may cause a delay in immediate care. A multidisciplinary approach to ensure ongoing review, monitoring and evaluation of interventions may improve the chances of an optimal outcome for the woman and baby.[54]

Table 17. Severe hypertension

Aspect	Consideration
Context	• The antihypertensive agent of choice for acute control has not been established, and initial therapy can be with one of a variety of agents[55] • Persistent or refractory severe hypertension may require repeated doses[6] • The concurrent administration of longer acting oral agents will achieve a more sustained BP lowering effect[6]
Indications for drug therapy	• Commence pharmacological treatment if[6,8,14]: o sBP is greater than or equal to 160 mmHg ***and/or*** o dBP is greater than or equal to 110 mmHg • sBP greater than or equal to 170 mmHg with or without dBP greater than or equal to 110 mmHg is a medical emergency and requires urgent treatment
Target BP	• sBP range of 130 to 150 mmHg • dBP range 80 to 90 mmHg • Aim for gradual and sustained lowering of BP, so blood flow to the fetus is not compromised[6]
Management	• Provide care in a high dependency unit[6] or birth suite • Strict control of BP • Monitor BP 15–30 minutes until stable[14] and then at a minimum 4 hourly • Perform a thorough assessment of maternal and fetal condition[52] • Recommend continuous fetal heart rate (FHR) monitoring[6,52]
Drugs not recommended	• Not generally recommended for treatment of hypertension: o Magnesium sulfate (although may be indicated for prevention of eclampsia)[6,52] o High dose diazoxide, nimodipine, chlorpromazine • Infusions of sodium nitroprusside or glyceryl trinitrate are recommended only when other treatments have failed and birth is imminent[6,52]

5.3.1 Antihypertensive drug choices for treatment of acute severe hypertension

Refer to an Australian pharmacopeia for full details of all drugs.

Table 18. Antihypertensive drug choices for treatment of acute severe hypertension

Drug	Dose	Route	Comment
#**Nifedipine**[67,68]	10–20 mg immediate release tablet	Oral	Onset: 30–45 minutes Repeat: after 45 minutes Maximum: 80 mg/day
Hydralazine[69]	5–10 mg (5 mg if fetal compromise)	IV bolus over 3–10 minutes	Onset: 20 minutes Repeat: every 20–40 minutes Maximum (cumulative): 30 mg/day
	Initially 10–20 mg/hour Maintenance 5–10 mg/hour	^Continuous IV infusion	Intermittent bolus preferred over infusion Titrate to BP response Refer to Appendix C: Hydralazine protocol
*__Labetalol__	Initial dose: 20 mg Repeat dose: 40–80 mg	IV bolus over 2 minutes	Onset: 5 minutes Repeat: every 10–20 minutes
	20–160 mg/hour	^Continuous IV infusion	Titrate to BP response to a maximum of 300 mg/24 hours
#**Diazoxide**[6]	15–45 mg	IV rapid bolus	Onset: 3–5 minutes Repeat: after 5 minutes Maximum (cumulative) 150mg Monitor blood glucose levels

*Refer to the Queensland Health List of Approved Medicines (LAM)
#Special Access Scheme (SAS) authority required. Note: Nifedipine formulations available
^May contribute to bradycardia and/or arrhythmias—liaise with a cardiac specialist and consider additional cardiac monitoring, as per hospital protocols

6 Pre-eclampsia

Severe hypertension, headache, epigastric pain, visual disturbances, oliguria, nausea, vomiting and reduced fetal movements, are ominous signs requiring urgent admission and management, as does any concern about fetal wellbeing.[6,27]

Table 19. Pre-eclampsia

Aspect	Consideration
Context	• Severity, progression and onset of clinical features are unpredictable[6] • Hypertension and proteinuria may be late or mild features of pre-eclampsia[6] • Birth is the definitive management and is followed by resolution of all components of pre-eclampsia, generally over a few days but may take up to 3 months[6]
Antihypertensive therapy	• Refer to: o Table 16. Oral antihypertensive drug therapy ***and*** o Table 18. Antihypertensive drug choices for treatment of acute severe hypertension
Progression	• Clinical progression is unpredictable, therefore close clinical surveillance is required for all women with pre-eclampsia[6] • Increasing severity may be indicated by: o Difficult to control BP o Deteriorating clinical condition including development of[6,27,70]: ▪ HELLP syndrome ▪ Eclampsia or impending eclampsia ▪ Deteriorating fetal status and/or increasing signs of fetal compromise [Refer to section 8.4 Signs of fetal compromise] • The definitive treatment is birth of the fetus and placenta[20]
Venous thromboembolism (VTE)	• Pre-eclampsia is an independent risk factor for venous thromboembolism (VTE) occurring in pregnancy or the postpartum period[6,27] • Refer to the Queensland Clinical Guideline *Venous thromboembolism prophylaxis in pregnancy and the puerperium*[71]
Fluid management	• Administration of large volumes of intravenous fluids before or after birth may contribute to a risk of pulmonary oedema or worsen peripheral oedema[6,72] • Consider additional fluid administration only prior to intravenous hydralazine, regional anaesthesia, immediate delivery, or in oliguric patients where a volume deficit is suspected[6] o In the immediate postpartum period, oliguria (defined in this population as less than 80 mL/4hours or 500 mL/24 hours) is common and physiological, and does not require fluid therapy unless the serum plasma creatinine is rising[6] • If no fluid deficit is apparent and if no other complications (e.g. postpartum haemorrhage), restrict post-birth intravenous crystalloids to 1500 mL in the first 24 hours[72] • Maintain strict hourly fluid balance monitoring[8] o An indwelling urinary catheter for hourly measurements may be required[73] • Diuretics are usually not recommended[27] unless there is fluid overload or pulmonary oedema[74] • Ensure ongoing obstetric and medical review
Postpartum	• Hypertension may persist for several days and up to three months[6] o Peak blood pressure may occur three to six days[75] following birth • All clinical and laboratory derangements of pre-eclampsia recover over several days and sometimes longer[6] • In the first few days after birth, liver enzyme elevations and thrombocytopenia will often worsen before they improve[6] • Refer to section 10 Postpartum for management post birth

6.1 Magnesium sulfate

Table 20. Magnesium sulfate

Aspect	Consideration
Context	• Magnesium sulfate is the anticonvulsant drug of choice for the prevention and treatment of eclampsia[6,73] o Magnesium sulfate may reduce women with pre-eclampsia progressing to eclampsia by 58%[76] • Do not prescribe magnesium sulfate for the prevention of eclampsia without discussion with a senior member of the obstetric team • If pre-eclampsia is evident with central nervous system dysfunction, magnesium sulfate is recommended during the antepartum, intrapartum and for the first 24 hours postpartum[73] periods • Symptoms or signs do not reliably predict onset of eclampsia[6] • Refer to Appendix D: Magnesium sulfate protocol
Suggested indications to commence therapy	• Eclampsia[73] • Severe pre-eclampsia, defined in the Magpie Trial[76,77] as: o sBP greater than or equal to 170 mmHg or dBP greater than or equal to 110 mmHg and at least 3+ of proteinuria ***or*** o sBP greater than or equal to 150 mmHg or dBP greater than or equal to 100 mmHg on two occasions and at least 2+ of proteinuria in the presence of at least two signs or symptoms of ''imminent eclampsia'' [refer Table 22. Eclampsia] • Pre-eclampsia with at least one sign of central nervous system irritability[8] [refer to Table 5. Diagnosis of pre-eclampsia] • When transfer to higher level service for pre-eclampsia management is required
Local protocols	• Develop local protocols that include recognition of magnesium sulfate risks, and assessment of maternal and fetal outcomes[6] • If not using standard pre-mixed 20% magnesium sulfate preparations, develop local dilution/preparation protocols

6.2 HELLP syndrome

HELLP syndrome is a manifestation of severe pre-eclampsia: **H**aemolysis, **E**levated **L**iver enzymes and **L**ow **P**latelet count (HELLP).[6]

Table 21. HELLP syndrome

Aspect	Consideration
HELLP syndrome	• Elements of HELLP include: o Thrombocytopenia (common) o Haemolysis (rare) o Elevated liver enzymes (common) • In a woman with pre-eclampsia, the presence of any of the following is an indicator of severe disease[14,68]: o Maternal platelet count of less than 100 x 10^9/L o Elevated transaminases (greater than twice the normal range)[7] o Microangiopathic haemolytic anaemia with fragments/schistocytes on blood film
Management	• Liaise with consultant obstetrician, obstetric physician, physician and/or haematologist and anaesthetist o Contact other facilities/services if necessary • If greater than 34+0 weeks gestation and/or condition deteriorating, plan birth o Consider antenatal corticosteroids however urgent delivery should not be delayed purely for the benefit of administration[6] • Magnesium sulfate infusion may be indicated [refer to section 6.1 Magnesium sulfate] • Consider platelet transfusion if: o Thrombocytopenia presents a hazard to operative birth[27] ***or*** o There is significant bleeding postpartum attributable to pre-eclamptic thrombocytopenia

7 Eclampsia

Eclampsia affects 1 in 2000 pregnancies worldwide and can be associated with significant morbidity and mortality. In Queensland, there were139 recorded cases of eclampsia between 2014 and 2019.[4]

Table 22. Eclampsia

Aspect	Consideration
Goals of treatment	• Terminate the seizure[6] • Prevent recurrence[6] • Control hypertension[75] • Prevent maternal and fetal hypoxia[75] • Refer to Section 9 Birth
Context	• There are no reliable clinical markers that predict eclampsia • Hypertension and proteinuria may be absent prior to the seizure[6] • Seizures may occur antepartum, intrapartum or postpartum usually within 24 hours of birth[6] • Reported incidence of eclampsia varies o In Australia in singleton pregnancies, the incidence of eclampsia is reported as 8.6/10,000 births which is 2.6% of women with pre-eclampsia[6]
Imminent eclampsia	• Defined as at least two of the following signs and/or symptoms[3,14] o Ongoing or recurring severe headaches o Visual disturbance o Altered level of consciousness o Hyperreflexia and/or sustained clonus
Treatment	• Follow the basic principles of resuscitation[6] • Magnesium sulfate is the anticonvulsant drug of choice for the prevention and treatment of eclampsia[8,75] o Refer to Appendix D: Magnesium sulfate protocol • If the seizure is ongoing or prolonged while initiating magnesium sulfate infusion, or reoccurs during administration of magnesium sulfate give[6]: o *Diazepam 5–10 mg IV at a rate of 2–5 mg/minute (maximum dose of 10 mg) ***or*** o *Midazolam 5–10 mg IV over 2–5 minutes[78] or IM ***or*** o *Clonazepam 1–2 mg IV over 2–5 minutes • Do not use phenytoin for eclampsia prophylaxis or treatment unless there is a contraindication to magnesium sulfate, or it is ineffective • Aim for BP below 160/100 mmHg
Post seizure care	• Consider delivery: o At gestational age of less than 34+0 weeks weigh the benefits and risks of continuation of pregnancy against maternal disease if birth has not occurred[6,8] • Close clinical surveillance is required in an appropriately staffed area • Provide woman centred care that allows her the opportunity to discuss the event with key members of the team

*Refer to an Australian pharmacopeia for full details of all drugs.

8 Antenatal surveillance

At each assessment following the detection of hypertension, systematically review the woman's wellbeing and fetal wellbeing allowing her to be an active participant in care and decision making.[6] Base further laboratory assessment on the recommendations contained in 3.3 Diagnosis of pre-eclampsia.

8.1 Model of care

Table 23. Model of care

Aspect	Consideration
Outpatient care	• Suitable for women with: o Mild to moderate hypertension without evidence of pre-eclampsia[6,8] o Where there are no geographical contraindications o Capacity to understand risk, and monitor their own blood pressure effectively where available (using a clinical calibrated machine,)[8,49] • Consider combined obstetric and physician outpatient management if there is: o Previous pregnancy complicated by pre-eclampsia o Known essential hypertension requiring drug therapy o Known renal disease o Other disease associated with hypertension (e.g. APLS) • Frequency of appointments is based on the individual clinical needs o Suggested review is initially weekly to fortnightly at a minimum[49] • Where available, assessment of the sFlt-1/PlGF ratio may help to determine risk of progression to pre-eclampsia o Refer to section 4.2 Screening for pre-eclampsia risk
Inpatient	• Consider review with multidisciplinary team where[6]: o There is concern for maternal or fetal wellbeing o sBP is greater than 140 mmHg or dBP greater than 90 mmHg, **and** signs and/or symptoms of pre-eclampsia are present • Consider use of a day assessment unit or maternity inpatient unit, depending on: o Assessment of biochemical/sonographic markers of pre-eclampsia and o Response to treatment
Inpatient monitoring	• BP four hourly, if stable • CTG daily (from 28+0 weeks gestation) • Consider daily ward urinalysis if proteinuria not previously confirmed, consistently elevated blood pressure or other clinical concerns o If significant proteinuria detected repeat daily testing is not required as results will not impact management decisions[6] o Refer to Table 25. Type and frequency of ongoing surveillance • Maintain accurate fluid balance record • Daily review (minimum) by obstetrician • Normal diet[6] • Actively consider thromboprophylaxis o Refer to Queensland Clinical Guideline: *Venous thromboembolic prophylaxis in pregnancy and the puerperium*[71]
Transfer of care	• Care options will depend on the services available at each facility[79] • Consultation with and/or transfer to a higher level service may be indicated for where[14]: o Pregnancy complicated by preterm[6] gestation with pre-eclampsia, severe pre-eclampsia, eclampsia or HELLP syndrome o Term pregnancy is complicated by eclampsia or HELLP syndrome o Any pregnancy in which the health care provider believes the health care facility will be unable to manage the complications of hypertension of pregnancy (e.g. preterm labour) • Consider magnesium sulfate therapy, and corticosteroids where appropriate prior to transferring women with severe pre-eclampsia, eclampsia or HELLP syndrome • If transfer is indicated, contact Retrieval Services Queensland (RSQ) on 1300 799 127

8.2 Maternal and fetal surveillance

Adverse perinatal outcome is increased in women with all subcategories of hypertensive disease in pregnancy compared to normotensive women.

Table 24. Maternal and fetal surveillance

Aspect	Consideration
Plan of care	• Serial surveillance is recommended[14] o Frequency, intensity and modality of maternal and fetal surveillance will depend on individual maternal and fetal characteristics[14] • Use a multidisciplinary approach • Discuss and agree to a plan (documenting clearly in the health record) including: o Previous history, risk factors for pre-eclampsia and gestational age at presentation[14] o Risks and benefits of care options o Indications for elective birth including maternal and fetal thresholds (biochemical, haematological and clinical) o Timing and mode of birth o The most appropriate care setting for birth considering the potential for preterm birth and acuity[6] o If and when antenatal corticosteroids are to be administered[14] o Maternal preferences
Maternal surveillance	• Assess women at each consultation[14] • If pre-eclampsia develops at a gestation lower than the neonatal capacity of the hospital consider transfer to a higher level facility[79] • Suggested surveillance is outlined in Section 8.3 Type and frequency of ongoing surveillance • Refer to Appendix A: Blood pressure management
Fetal surveillance	• Evaluate fetal growth restriction[14] and wellbeing using USS, and CTG if greater than or equal to 28+0 weeks gestation[6] • Assessment of growth trends and Dopplers by serial USS[6] • Symphysio-fundal height measurement is a poor screening tool for fetal growth restriction (FGR)[6] and has limited utility in clinical management

8.3 Type and frequency of ongoing surveillance

Common protocols are based on expert opinion and have not been tested in prospective randomised trials.[6]

Table 25. Type and frequency of ongoing surveillance

Classification	USS and other surveillance[6]		Frequency[6]
Gestational hypertension	Maternal	• Urinalysis for protein • #Pre-eclampsia bloods	• Consider 1–2 per week • Consider weekly
	Fetal	• USS	• At diagnosis and 2–4 weekly
Pre-eclampsia	Maternal	• Urinalysis for protein (quantify if 1+) • #Pre-eclampsia bloods	• At diagnosis (repeated if negative) • Twice weekly (or more if unstable)
	Fetal	• USS • CTG	• At diagnosis and 2 weekly (or more if indicated)[8] • Twice weekly (or more if indicated)
Pre-eclampsia with FGR	Maternal	• As for maternal pre-eclampsia	
	Fetal	• USS • CTG	• *On admission and weekly (or more if indicated) • Twice weekly (or more if indicated)
Chronic hypertension	Maternal	• Urinalysis for protein • #Pre-eclampsia bloods	• Each visit • If sudden increase in BP or new proteinuria
	Fetal	• Early dating USS	• First trimester
		• USS	• Third 3rd trimester (or more if indicated)

*Weekly: Amniotic Fluid Index (AFI) and Doppler, Fortnightly: growth and wellbeing, AFI and Doppler
#Pre-eclampsia bloods: full blood count (FBC), electrolytes and creatinine, liver function test (LFT)

8.4 Signs of fetal compromise

Currently, there is no single fetal monitoring test to accurately predict fetal compromise in women with pre-eclampsia. A combination of tests and scheduled serial fetal surveillance with USS (when there is FGR) is generally recommended.[8]

Table 26. Signs of fetal compromise

Aspect	Consideration
Fetal movement perception	• Perceived changed or decreased fetal movements • Refer to Queensland Clinical Guidelines *Fetal movements*[80]
Fetal monitoring	• Abnormal FHR/CTG
Deepest amniotic fluid pocket	• Deepest vertical pocket (DVP) 2 cm or less • Amniotic fluid index (AFI) 5 cm or less (less specific test) • Oligohydramnios associated with adverse perinatal outcomes
USS assessment of fetal growth	• In the absence of congenital anomalies, growth changes may include: o Estimated fetal weight (EWF) less than 10th centile o Fall in growth velocity (abdominal circumference (AC) or EFW) of greater than 2 standard deviations or 50th centiles, or fall to less than 10th centile (severe if less than 3rd centile)[81] o Symmetrical vs asymmetrical growth (refer to Queensland Clinical Guidelines *Term small for gestational age baby*[82])
Umbilical artery (UA) flow Doppler	• UA pulsatility index greater than 95th centile (early or late FGR)[81] • Severe if absent or reversed end diastolic flow
Ductus venosus Doppler	• Absent or reversed “a” wave • Identification of an abnormal ductus venosus waveform is not diagnostic in isolation when there is no other Doppler abnormality
Middle cerebral artery Doppler	• Cerebral redistribution (decreased resistance or ‘brain sparing effect’) • Paradoxically the flow can revert back to a high resistance pattern when the pathology has not yet resolved–this is a very poor prognostic sign and not diagnostic when used in isolation

9 Birth

Table 27. Planning birth

Aspect	Consideration
Multidisciplinary approach	• Consult early with a multidisciplinary team • Inform the anaesthetist when a woman with pre-eclampsia is admitted
Indications to consider birth[6]	• Non-reassuring fetal status[8] • Severe FGR/lack of interval growth • Gestational age greater than or equal to 37+0 weeks[49] • Eclampsia • Placental abruption • Acute pulmonary oedema • Inability to control hypertension despite adequate antihypertensive therapy[8] • Deteriorating platelet count, or liver or renal function[8] • Persistent neurological symptoms[8] • Persistent epigastric pain, nausea/vomiting with abnormal liver function tests[8]
Stabilisation prior to birth	• Stabilise the woman before birth, considering fetal condition, including: o Control of eclampsia or prophylaxis against eclampsia if indicated o Control of severe hypertension[6] o Correction of coagulopathy o Attention to fluid status • Refer to section 9.1 Timing of birth
Mode of birth	• Recommend vaginal birth unless a caesarean section is required for other obstetric indications[17,49] • If vaginal birth is planned and the cervix is unfavourable, recommend cervical ripening to increase the chance of successful vaginal birth[17]
Caesarean section anaesthesia	• In the absence of contraindications, all of the following are acceptable methods of anaesthesia: epidural, spinal, combined spinal-epidural, and general anaesthesia (GA)[17] • When clinically appropriate, spinal is preferred to epidural (because of more rapid onset) and to GA (because it avoids hypertensive response to intubation)[17,68]

9.1 Timing of birth

There is limited high quality evidence to inform decisions about optimal timing of birth. Individualise care and take into account relative maternal and fetal risks.[8,68]

Table 28. Timing of birth

Aspect	Consideration
Context	• Timing of birth is dependent on evaluation of maternal and fetal risks • Requires a multidisciplinary team approach with continual consultation and agreement with the woman[14,83] • For women prescribed beta blockers discuss the need for monitoring of neonatal blood glucose levels after birth o Refer to Queensland Clinical Guideline *Newborn hypoglycaemia*[84] • While optimising the timing of birth is the goal of treatment, also consider: o Intervention versus expectant management and the impacts these can have on the woman and the fetus (particularly considering gestational age)[7] o Administration of corticosteroids for fetal lung maturity • Induction of labour from 37+0 weeks in women with hypertension or mild pre-eclampsia, may reduce the risk of poor maternal outcomes (predominantly reduction in severe hypertension) without an increase in the CS rate[85]
Mild to moderate hypertension	• For women at low risk of adverse outcomes, consider expectant management beyond 37+0 weeks[8] o Refer to Table 28. Timing of birth for considerations on gestations greater than 37+0 weeks
Pre-eclampsia	• Timing of birth is dependent on the severity of the disease and the gestational age at which it presents[68] o Prolongation of pregnancy carries no benefit for the woman but may be desirable at early gestations to improve the fetal outcomes and prognosis[68]
HELLP syndrome	• Expectant management is harmful with a 6.3% incidence of maternal death and an increased risk of placental abruption[6] • Plan birth as soon as feasible
Less than 34 weeks gestation	• Aim to prolong pregnancy where possible to improve fetal prognosis[6,68] • Refer to the Queensland clinical guideline *Preterm labour and birth*[19] regarding: o Antenatal corticosteroids for fetal lung maturity o Magnesium sulfate for fetal neuroprotection if less than 30 weeks gestation o Retrieval and transfer
34+0–36+6 weeks gestation	• Planned early delivery is associated with higher levels of respiratory distress syndrome (RR 2.24, 95% CI 1.20 to 4.18) and neonatal intensive care admission (RR 1.65, 95% CI 1.13 to 2.40)[83] • Consider expectant monitoring unless the clinical situation deteriorates • Consult with higher level services as appropriate
Greater than 37+0 weeks gestation	• For women at low risk of adverse outcomes, consider expectant management • Plan birth taking into consideration resourcing requirements and available maternity and neonatal services[6] • If severe pre-eclampsia, do not delay birth (except to achieve stabilisation if possible)

9.2 Intrapartum care

Table 29. Intrapartum care

Aspect	Consideration
Drug therapy	• Continue antihypertensive drug therapy throughout labour and birth[8,14]
Monitoring	• Close clinical surveillance is required • Monitor BP hourly[14] as a minimum • Continuous CTG is recommended for gestations greater than 28+0 weeks • In women with severe pre-eclampsia, consider limiting fluid intake to 60–80 mL/hr[8,14] and monitor hourly fluid balance • Obtain IV access • An epidural (in the absence of contraindications) is a useful adjunct therapy for BP control[6] o Discuss with anaesthetist
Second stage	• There is no evidence to guide management of second stage[14] • Assistance is not routinely required but may be necessary if: o BP is poorly controlled o Progress is inadequate o There are premonitory signs of eclampsia • If BP is within target range, refer to Queensland Clinical Guideline *Normal birth*[86] for management of second stage • If BP does not respond to initial drug therapy, advise assisted/operative birth[14]
Third stage	• Women with pre-eclampsia, eclampsia and HELLP syndrome may be at increased risk of primary postpartum haemorrhage o Recommend active management of third stage[8] • **Do not routinely** give ergometrine or syntometrine as it may produce an acute rise in BP[7] o Consider use in limited circumstances and under the guidance of a specialist team and with close monitoring o Consider syntocinon o Consider carbetocin* • Refer to Queensland Clinical Guideline: *Primary postpartum haemorrhage*[87]
Additional investigations	• Consider placental histopathology, particularly if early onset hypertension and/or fetal growth restriction o Refer to Queensland Clinical Guidelines *Term small for gestation age baby*[82]

*****Not on Queensland Health List of Approved Medicines (LAM). Refer to an Australian pharmacopeia for full details of all drugs.

10 Postpartum

Hypertension, proteinuria, eclampsia and other adverse conditions of pre-eclampsia may develop for the first time during the postpartum period.

Table 30. Postpartum

Aspect	Consideration
Context	• After birth, clinical and laboratory derangements of pre-eclampsia improve over several days but may take up to 3 months for complete resolution[6] • Liver enzyme elevations and thrombocytopenia will often worsen in the first few days after birth before they improve • De novo postpartum hypertension is most common on days 3–6[17] • Hypertension may persist for several days[6] with peak postpartum BP occurring on days 3–6[73,88] • 32–44% of eclampsia occurs in the postpartum period[7]
Target BP	• sBP less than or equal to 140 mmHg • dBP less than or equal to 90 mmHg
Monitoring	• Closely monitor (4 hourly or more frequently) BP, pulse rate, respiratory rate and oxygen saturation until: o BP is stable o Urine output has normalised o Blood investigations are stable or improving • Reduce frequency of monitoring after discussion with the treating obstetric/medical team • Use Queensland Maternity Early Warning Tools (Q-MEWT) as indicated • Ask women about severe headache and epigastric pain each time BP is measured • For women prescribed beta blockers discuss the need for monitoring of neonatal blood glucose levels after birth o Refer to Queensland Clinical Guideline *Newborn hypoglycaemia*[84]
VTE prophylaxis	• Actively consider VTE prophylaxis • Refer to the Queensland clinical guideline *VTE prophylaxis in pregnancy and the puerperium*[71]
Drug therapy	• Continue use of antenatal antihypertensive drug therapy o If prescribing antihypertensives that require frequent administration on discharge, consider risk of non-compliance with drug therapy o If methyldopa commenced during pregnancy, consider ceasing postpartum and commence alternative therapy as it is associated with increased risk of clinical depression[6] • Reduce or cease when hypertensive changes are resolving o Avoid abrupt withdrawal to reduce risk of rebound hypertension • If persistently hypertensive (sBP greater than or equal to 140 mmHg or dBP greater than or equal to 90 mmHg), start antihypertensive drug therapy (if not commenced prior to birth) o If severe hypertension, refer to Section 5.3.1 Antihypertensive drug choices for treatment of acute severe hypertension
Non-steroidal anti-inflammatory drugs (NSAID)	• In women with severe pre-eclampsia and/or renal impairment (especially in volume depleted women[8]) NSAIDs are not generally recommended[49] • Consider use of NSAIDs on an individual case basis
Breastfeeding	• First and second line drugs are considered compatible with breastfeeding[6] o Advise women that antihypertensive medications can pass into breast milk however unlikely to have any significant clinical impact on the newborn[14] • Antihypertensive drugs without reported adverse reactions in breastfed infants include: o Nifedipine[6,7] o Enalapril[6,7] o Captopril[6,7] o Metoprolol[6,7] o Labetalol[89] o Atenolol (other agents may be preferred if breastfeeding a preterm infant or baby less than 3 months)[90] • Refer to Queensland Clinical Guideline *Breastfeeding initiation*[91]

10.1 Discharge and follow up

Following a pregnancy complicated by hypertensive disorders of pregnancy, the woman has an increased risk of cardiovascular and medical conditions in future pregnancies of gestational hypertension and pre-eclampsia as well as an increased risk of longer term cardiovascular and medical conditions.[56] Refer to Section 4.5 Adverse maternal outcomes associated with hypertensive disorders.

Table 31. Discharge and follow up

Aspect	Consideration
Discharge	• Consider the risk of late seizures and the peak postpartum BP when timing discharge • BP surveillance post discharge consider: o Preferred first BP check within 7–10 days after discharge (earlier if symptomatic), to determine need for further evaluation or treatment[49,75] o Consider weekly follow up for women discharged on antihypertensives to monitor compliance[11] and to facilitate tapering of medication ▪ May be done with GP or at specialist clinics o Recommend comprehensive follow-up after 12 weeks to ensure resolution of hypertensive disorder related changes, and ascertain the need for further investigation and management[8] • Inform the GP and/or other relevant healthcare providers about the events of the pregnancy • Provide advice regarding: o Future pregnancy risk reduction o Management (e.g. prophylaxis with aspirin) o Contraceptive options
ACE inhibitors	• If prescribed: o Discuss the importance of adequate contraception as the use of ACE inhibitors is contraindicated in pregnancy[8] o If considering pregnancy, advise woman to discuss alternative antihypertensive treatment with their healthcare provider(s) [56]
Follow up screening	• Offer screening for predisposing factors (including pre-existing hypertension, underlying renal disease and antiphospholipid syndrome) to women with a history of early onset pre-eclampsia, or antiphospholipid antibodies[7] • Recommend GP surveillance of traditional cardiovascular risk[92] markers in all women diagnosed with a hypertensive disorder of pregnancy (e.g. annual BP check, serum lipids and blood glucose level)[8] • Offer preconception/early pregnancy counselling for discussion of risk factors and preventative therapies (e.g. calcium supplementation, low dose aspirin)[7]
Lifestyle advice	• For healthy future pregnancies advise women that there are benefits from exercising and maintaining a healthy lifestyle and avoiding smoking[6,7] • Encourage overweight and obese women to attain a healthy BMI for long term health o Refer to Queensland Clinical Guideline *Obesity in pregnancy*[93]
Psychological support	• Offer postnatal counselling regarding the pregnancy and birth experience, including formal postnatal review to discuss the events of the pregnancy if required

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Appendix A: Blood pressure measurement

Technique	Procedure[16]	Rationale
Position of woman	• Seated • Feet supported on a flat surface • Arm supported horizontally at the level of the heart[88] • Allow to rest for 5 minutes prior to measurement • Avoid supine posture • In labour, use left arm in lateral recumbency • Measure on both arms at initial visit • If BP consistently higher in one arm, use the arm with the higher values for all BP measurements	• Different arm positions can produce significantly different measurements[88] • 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	• Correctly sized cuff is necessary for accurate measurement
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[88] • Use an aneroid device that is validated for use in pregnancy	• Ensures accurate BP measurement • Mercury devices considered the gold standard[88], but use not supported in Queensland Health due to occupational health and safety concerns
sBP measurement	• Palpate BP at the brachial artery • Inflate cuff to 30 mmHg above where pulse disappears • Deflate cuff slowly at approximately 2 mmHg per second • Use Korotkoff phase I (first sound heard) • Take readings to the nearest 2 mmHg (not nearest 0 or 5 mmHg)	• Ensures correct placement stethoscope • Necessary for accurate systolic and diastolic estimation • Avoids bias through digit preference (i.e. observers estimating BP to nearest 0 or 5 mmHg)
dBP measurement	• Record dBP using Korotkoff phase V (i.e. when sounds disappear) • If phase V cannot be detected use Korotkoff phase IV (i.e. when sounds muffle)	• 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)
Other factors affecting BP readings[18]	• Stress and anxiety • Talking while BP taken • Temperature • Full bladder	• Increase BP
	• Tobacco products (containing nicotine) • Alcohol • Caffeine	• Increase/decrease BP–avoid for 30 minutes prior to measurement

Appendix B: Interpretation of pre-eclampsia investigations

Investigation	Gestation (weeks)	Reference range*	Units	Description if pre-eclampsia
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		
	Greater than 42	5.7–16.9		
Haemoglobin (Hb)	1–12	110–143	g/L	**Higher** Due to haemoconcentration, unless there is haemolytic anaemia
	13–24	100–137		
	25–42	98–137		
	Greater than 42	98–143		
Platelets	1–12	170–390	$x10^9$/L	**Lower** Falling platelet count associated with worsening disease
	13–24	170–410		
	25–42	150–430		
	Greater than 42	150–430		
Haptoglobin (Hp)	1–42	0.36–1.95	g/L	**Lower** Suggests haemolysis
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** with severe DIC
Glucose	0–42	3.0–7.8	mmol/L	**Low** in acute fatty liver of pregnancy
Serum Creatinine	0–42 (15–19 years)	38–82	µmol/L	**Higher** Due to haemoconcentration and/or renal failure
	0–42 (19–60 years)	45–90	µmol/L	
Bilirubin (Total)	0–42	Less than 20	µmol/L	**Higher** Unconjugated from haemolysis, or conjugated from liver dysfunction
Albumin	0–26	35–50	g/L	**Lower**
	27–40	33–40		
AST	0–42	Less than 31	U/L	**Higher**
ALT	0–42	Less than 34	U/L	**Higher**
LDH	0–42	120–250	U/L	**Higher**
Random protein to creatinine ratio	0–42	Less than 30	mg/mmol	**Higher**

Appendix C: Hydralazine protocol

Caution: refer to the Australian product information for complete drug information	
Hydralazine	
Indication	• Acute control of severe hypertension
Contraindications	• Known hypersensitivity • SLE • Severe tachycardia (greater than 125 bpm) • Myocardial insufficiency • Right ventricular heart failure
Precautions	• Suspected/confirmed coronary artery disease • Renal impairment • Hepatic impairment • Cerebrovascular disease
Route	• Intravenous
Intermittent IV bolus	• 5–10 mg IV over 3–10 minutes (5 mg if fetal compromise) • If required repeated doses 5 mg IV 20 minutes apart • If maternal pulse greater than 125 beats/minute, then cease • If 20 mg total given or longer term BP control required, consider an infusion • Maximum cumulative dose is 30 mg over 24 hours
Continuous IV infusion	• Commence at 10–20 mg/hour IV via controlled infusion device, and titrate to BP • If maternal pulse greater than 125 beats/minute consider reducing/ ceasing infusion • Maintenance dosage 5–10 mg/hour via controlled infusion device
Side effects	• Tachycardia • Headache • Flushing • Palpitations
Monitoring during bolus doses	• Monitor BP, pulse and oxygen saturations o Every 5 minutes during administration and until stable, then o Hourly for 4 hours • *Continuous CTG if ante/intrapartum
Monitoring during infusion	• Monitor BP every 15 minutes until stable, then o Hourly for duration of infusion (unless otherwise instructed) • *Continuous CTG if ante/intrapartum
Additional considerations during monitoring	• Maintain strict fluid balance monitoring • Monitor, as clinically appropriate: o Full blood count o Liver function test o Urea and electrolyte levels o Coagulation profile

*Consider fetal physiology and use caution when interpreting CTGs at less than 28+0 weeks gestation

Appendix D: Magnesium sulfate protocol

Caution: refer to the Australian product information for complete drug information	
Magnesium sulfate for pre-eclampsia and/or eclampsia	
Resources required	• One to one midwifery care in birth suite or high dependency unit for the duration of therapy • Dedicated IV line for magnesium sulfate using a controlled infusion device • Resuscitation and ventilator support immediately available • Calcium gluconate 10% (0.22 mmol/mL) 10 mL vial available in case of respiratory depression/overdose
Contraindications	• Maternal cardiac conduction defects (heart block) • Hypermagnesaemia
Precautions	• Myasthenia gravis • If reduced renal function, monitor plasma magnesium level/urine output
Loading dose	• 4 g IV infusion over 20 minutes via controlled infusion device
Maintenance dose	• 1 g/hour IV for 24 hours after last seizure or birth (whichever is latest), then review for continuation/cessation • If impaired renal function: o Reduce maintenance infusion rate to 0.5 g/hour o Discuss serum monitoring requirements with an obstetrician
Seizures	• If new onset seizure or persistent seizures during magnesium sulfate infusion (loading or maintenance) o Give a further 2 g IV over 5 minutes o If seizures persist may be repeated in a further 2 minutes
Side effects	• Related to hypermagnesaemia • Common (greater than 1%): nausea and vomiting, sensation of heat/flushing • Infrequent (0.1–1%): headache, dizziness
Baseline observations	• BP, pulse, respiratory rate, level of consciousness • Oxygen saturation (SpO_2) • Deep tendon reflexes • If antepartum: abdominal palpation, FHR/CTG
Monitoring during loading dose	• BP, pulse and respiratory rate every 5 minutes (for minimum 20 minutes) until stable • Continuous SpO_2 • If in labour monitor contractions for 10 minutes every 30 minutes • *Continuous CTG if greater than 28+0 weeks gestation o Document reason if CTG not able to be performed • Auscultate FHR every 15–30 minutes if less than 28+0 weeks gestation • Observe for side effects • Check deep tendon reflexes (patellar; if epidural insitu, biceps) after completion of loading dose o Notify obstetrician if absent and do not commence maintenance dose
Monitoring during maintenance infusion	• BP, pulse, respiratory rate and SpO_2 every 30 minutes • Temperature every 2 hours • If in labour, monitor contractions for 10 mins every 30 mins • *Continuous CTG if greater than 28+0 weeks gestation o Auscultate FHR every 15–30 minutes if less than 28 weeks gestation • Strict fluid balance monitoring and documentation o Notify medical officer if urine output less than 25 mL/hour o Indwelling urinary catheter is recommended • Deep tendon reflexes hourly o Record as A=Absent, N=Normal, B=Brisk o If renal function normal serum monitoring is not required Therapeutic serum magnesium levels are 1.7–3.5 mmol/L
Discontinuation and urgent medical review	• Respiratory rate less than 12 breaths/minute or more than 4 breaths/minute below baseline • dBP decreases more than 15 mmHg below baseline • Absent deep tendon reflexes • Urine output less than 80 mL/4 hours • Magnesium serum levels greater than 3.5 mmol/L
Ceasing therapy	• Before discontinuing therapy ensure clinical improvement evident (e.g. absence of headache, epigastric pain) and condition stable

*Consider fetal physiology and use caution when interpreting CTGs at less than 28+0 weeks gestation

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