Royal Hospital for Women (RHW)
BUSINESS RULE
COVER SHEET

NAME OF DOCUMENT	*Hypertension in Newborn Infants*
TYPE OF DOCUMENT	*Clinical Business Rule*
DOCUMENT NUMBER	
DATE OF PUBLICATION	15 June 2023
RISK RATING	*Low*
REVIEW DATE	*2028*
FORMER REFERENCE(S)	*N/A*
EXECUTIVE SPONSOR	*S Bolisetty (Medical Co-Director Newborn Care Centre); S Wise (Nursing Co-Director Newborn Care Centre)*
AUTHOR	*C Godkin (Paediatric Advanced Trainee), S Bolisetty (Medical Co-Director)*
SUMMARY	*To identify and manage neonatal hypertension in the NICU*

Royal Hospital for Women (RHW)
BUSINESS RULE

Hypertension in Newborn Infants

This Clinical Business Rule is developed to guide safe clinical practice in Newborn Care Centre (NCC) at The Royal Hospital for Women. Individual patient circumstances may mean that practice diverges from this Clinical Business Rule. Using this document outside the Royal Hospital for Women or its reproduction in whole or part, is subject to acknowledgement that it is the property of NCC and is valid and applicable for use at the time of publication. NCC is not responsible for consequences that may develop from the use of this document outside NCC.

1. BACKGROUND

Defining hypertension during the newborn period is challenging.[1] Infants with blood pressure (BP) values persistently above the 95th percentile should be closely monitored, and those with BP values over the 99th percentile should be investigated and potentially treated depending on the clinical situation.[2]

2. RESPONSIBILITIES

Medical and Nursing Staff

3. PROCEDURE

3.1 Clinical Practice

1. Monitor blood pressure as per the Nursing Clinical Business Rule, “Blood Pressure Monitoring in Newborn Care Centre”.
2. Identify the neonate with BP ≥95th percentile:
   - In the first 2 weeks of life – see Figure 1 (based on gestational age or birth weight).
   - After the first 2 weeks of life – see Table 1

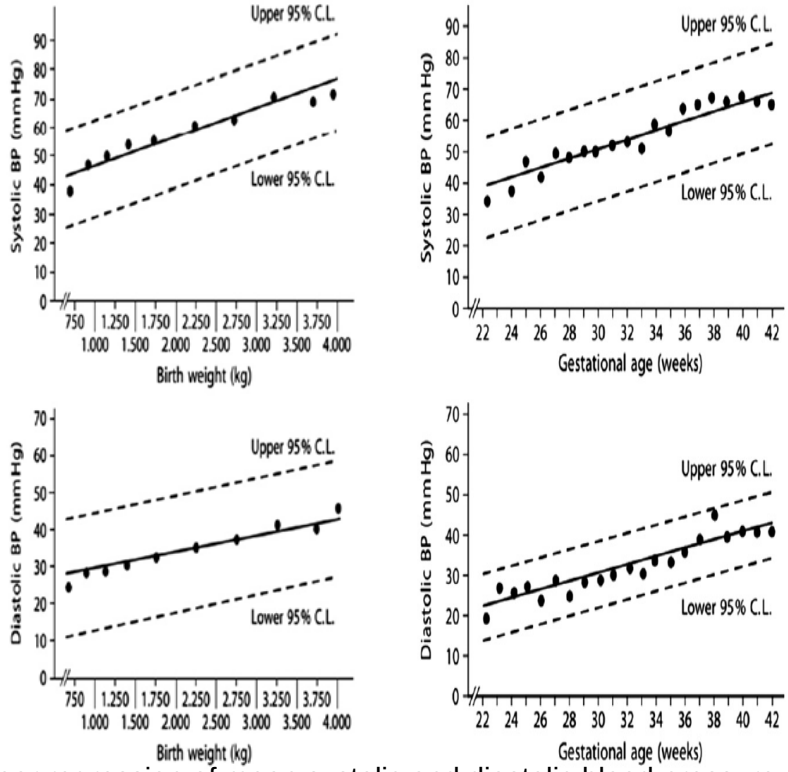

Figure 1. Linear regression of mean systolic and diastolic blood pressure values (and 95% confidence intervals) depending on gestational age and birth weight on day 1 of life.[3]

Royal Hospital for Women (RHW)
BUSINESS RULE

Hypertension in Newborn Infants

Table 1. Estimated BP in well infants ranging from 26-44 weeks post-conceptual age, from 2 weeks of life onwards.[4]

Corrected Gestational Age		50th percentile	95th percentile	99th centile
26 weeks				
	SBP	55	72	77
	DBP	30	50	56
	MAP	**38**	**57**	**63**
28 weeks				
	SBP	60	75	80
	DBP	38	50	54
	MAP	**45**	**58**	**63**
30 weeks				
	SBP	65	80	85
	DBP	40	55	60
	MAP	**48**	**65**	**68**
32 weeks				
	SBP	68	83	88
	DBP	40	55	60
	MAP	**48**	**62**	**69**
34 weeks				
	SBP	70	85	90
	DBP	40	55	60
	MAP	**50**	**65**	**70**
36 weeks				
	SBP	72	87	92
	DBP	50	65	70
	MAP	**57**	**72**	**71**
38 weeks				
	SBP	77	92	97
	DBP	50	65	70
	MAP	**59**	**74**	**79**
40 weeks				
	SBP	80	95	100
	DBP	50	65	70
	MAP	**60**	**75**	**80**
42 weeks				
	SBP	85	98	102
	DBP	50	65	70
	MAP	**62**	**76**	**81**
44 weeks				
	SBP	88	105	110
	DBP	50	68	73
	MAP	**63**	**80**	**85**

3. Check for any risk factors for hypertension within the NICU setting including: Umbilical artery catheter; Chronic lung disease; Coarctation of aorta; Patent ductus arteriosus; Renal malformations / renovascular disease / acute renal failure; Antenatal maternal hypertension; High-risk medications (steroids, caffeine, inotropes); Maternal recreational drugs (amphetamine, cocaine, heroin) or steroid exposure; Intraventricular Haemorrhage[5]
4. Consider investigations depending on the clinical situation[3]:
   - First line investigations include: Repeat clinical examination; 4-limb BPs; Medication Review; FBC, EUC, calcium; Urinalysis +/- culture; chest x-ray; Renal ultrasound with dopplers
   - Second/third line investigations include: Echocardiography; Cranial ultrasound +/- MRI; Plasma renin; Urine VMA / HVA; Cortisol, aldosterone; TFTs; Renal angiography
5. Correct reversible or iatrogenic causes (Examples include: Inotropes; steroids; caffeine; hypercalcaemia; volume overload).
6. Consult cardiologist and/or nephrologist as appropriate.
7. Look for signs of acute severe hypertension, defined as hypertension with end-organ dysfunction such as heart failure, stroke or seizures.
8. In acute severe hypertension:
   - Consider continuous invasive BP monitoring, otherwise record 10-15 minutely non-invasive BP
   - Correct or reverse any iatrogenic causes
   - Initiate continuous intravenous infusion of either sodium nitroprusside (vasodilator) or esmolol (beta-blocker)
   - Avoid reducing BP too rapidly (rapid drop may cause cerebral ischaemia or haemorrhage)
9. For stable infant but with persistent moderate (>99th percentile) hypertension:
   - Enteral medications may suffice
   - First line agents can be either hydralazine (vasodilator) or amlodipine (calcium channel blocker)
   - Intermittent hydralazine doses may be given intravenously if oral therapy is not tolerated.[1]
   - Avoid angiotensin converting enzyme (ACE) inhibitors such as captopril in preterm infants until 44 weeks' corrected age. ACE inhibitors may impair the final stages of renal maturation in these infants.[1]
10. Surgery may be the best treatment for conditions such as coarctation of the aorta, renal artery stenosis, ureteral obstruction.

3.3 Educational Notes

- The 2017 American Academy of Pediatrics Clinical Practice Guideline on Childhood Hypertension recommends use of the tables created by Dionne et al. as the best available reference data.[6]
- In preterm infants, blood pressure (BP) rapidly changes over the first weeks of life.
- The phase of most rapid increase in BP occurs over the first 2–3 weeks of life in infants born <32 weeks' gestation and over the first week of life in infants born at 32–36 weeks' gestation. After the initial rapid rise in BP preterm infants settle into a phase of slower, and steadily increasing, BP by postmenstrual age.[1]
- Most hypertensive newborns are asymptomatic and will be discovered on routine monitoring of vital signs.[1]
- There is limited data on the effects of chronic hypertension in neonates.
- It is also unclear on the effects of antihypertensive therapies in neonates. Clinical criteria for initiating therapy are not well defined. Most available recommendations are expert opinions.
- Other than in acute hypertensive crises, it is recommended to liaise with cardiologists or nephrologists or paediatric intensive care specialists for further advice and guidance for treatment of neonatal hypertension.

- ACE inhibitors (e.g. captopril) should be reserved until preterm babies are 44 weeks' corrected age due to concerns that these medications may adversely affect the renin-angiotensin-aldosterone system and nephrogenesis in these preterm infants.[1]
- Beta blockers should be avoided in infants with chronic lung disease, however, diuretics may have a role due to the dual benefit of improvement in pulmonary status as well as the antihypertensive effects.[7] Beta-blockers should also be avoided in ischaemic or traumatic head injury.[1,2]
- Up to a third of babies admitted to the NICU may develop hypertension after discharge from the NICU. For this reason, it is recommended that regular screening of BP at follow-up is performed, ideally up to 3 years of age, in line with recommendations from the American Academy of Pediatrics.[6]

3.4 Abbreviations

NCC	Newborn Care Centre	MRI	Magnetic Resonance Imaging
BP	Blood Pressure	VMA	Vanillylmandelic Acid
NICU	Neonatal Intensive Care	HMA	Homovanillic Acid
FBC	Full Blood Count	TFTs	Thyroid Function Tests
EUC	Electrolytes, Urea, Creatinine	ACE	Angiotensin Converting Enzyme

3.5 References

1. Starr MC, Flynn JT. Neonatal hypertension: cases, causes, and clinical approach. Pediatr Nephrol 2019;34:787-99.
2. Flynn JT. The hypertensive neonate. Semin Fetal Neonatal Med 2020;25:101138.
3. Zubrow AB, Hulman S, Kushner H, et al. Determinants of blood pressure in infants admitted to neonatal intensive care units: a prospective multicenter study. Philadelphia Neonatal Blood Pressure Study Group. J Perinatol 1995;15:470-9.
4. Dionne JM, Abitbol CL, Flynn JT. Hypertension in infancy: diagnosis, management and outcome. Pediatr Nephrol 2012;27:17-32.
5. Sharma D, Pandita A, Shastri S. Neonatal hypertension: an underdiagnosed condition, a review article. Curr Hypertens Rev 2014;10:205-12.
6. Flynn JT, Kaelber DC, Baker-Smith CM, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics 2017;140:e20171904.
7. Jenkins RD, Aziz JK, Gievers LL, et al. Characteristics of hypertension in premature infants with and without chronic lung disease: a long-term multi-center study. Pediatr Nephrol 2017;32:2115-24.

4. RELATED BUSINESS RULES AND POLICY DOCUMENTS

- Royal Hospital for Women Nursing Clinical Business Rule – Blood Pressure Monitoring in Newborn Care Centre

Hypertension in Newborn Infants

5. CULTURAL SUPPORT

- When clinical risks are identified for an Aboriginal family, they may require additional supports. This may include Aboriginal health professionals such as Aboriginal liaison officers, health workers or other culturally specific services.
- For a Culturally and Linguistically Diverse CALD family, notify the nominated cross-cultural health worker during Monday to Friday business hours.
- If the family is from a non-English speaking background, call the interpreter service: NSW Ministry of Health Policy Directive PD2017_044-Interpreters Standard Procedures for Working with Health Care Interpreters.

6. IMPLEMENTATION PLAN

This Clinical Business Rule will be distributed to all medical, nursing and midwifery staff via @health email. The Clinical Business Rule will be discussed at ward meetings, education and patient quality and safety meetings. Education will occur through in-services, open forum and local ward implementation strategies to address changes to practice. The staff are asked to respond to an email or sign an audit sheet in their clinical area to acknowledge they have read and understood the Clinical Business Rule. The Clinical Business Rule will be uploaded to the Clinical Business Rule tab on the intranet and staff are informed how to access.

7. RISK RATING

- Low (5 years)

8. NATIONAL STANDARDS

- Standard 1 Clinical Governance
- Standard 4 Medication Safety
- Standard 5 Comprehensive Care
- Standard 6 Communicating for Safety
- Standard 8 Recognising and Responding to Acute Deterioration

9. REVISION AND APPROVAL HISTORY

Date	Revision No.	Author and Approval
15/06/2023		Endorsed by Safety and Quality Committee
18/5/2023	1	C Godkin (Paediatric Advanced Trainee); S Bolisetty (Medical Co-Director); Primary document approved NCC CBR Committee