



# Blood pressure assessment guidelines

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**Table 1: The strength of recommendations according to the level of evidence(1).**

	Clarity of risk/benefits	Quality of supporting evidence	Implications
1A Strong recommendation with high-quality evidence	Benefits outweigh risk, or vice versa	With consistent evidence from RCTs or overwhelming evidence from other forms, further research is unlikely to change our confidence in the estimate of benefit and risk.	Strong recommendations can apply to most patients in most circumstances without reservation.
1B Strong recommendation with moderate-quality evidence	Benefits outweigh risk, or vice versa	Evidence from RCTs, with significant limitations (inconsistent results or methodology flaws)	Strong recommendation, and applies to most patients.
1C Strong recommendation with low quality of evidence	Benefits outweigh risk, or vice versa	Evidence from observational studies or RCTs with significant flaws.	Strong recommendation, and applies to most patients, however with low quality.
2 A Weak recommendation with high-quality evidence	Benefits closely balanced with risks and burdens	With consistent evidence from RCTs or overwhelming evidence from other forms, further research is unlikely to change our confidence in the estimate of benefit and risk.	Weak recommendation, the best action is to defer based on circumstances or patient values.
2B Weak recommendation with moderate-quality evidence	Benefits are closely balanced with risk with uncertainty in the estimates of benefits	Evidence from RCTs, with significant limitations (inconsistent results or methodology flaws)	Weak recommendation, alternative approaches likely to be better for some patients under some circumstances.
2C Weak recommendation with weak quality evidence	uncertainty in the estimates of benefits, risks, and burden	Evidence from observational studies or RCTs with serious flaws.	Very weak recommendation; other alternatives may be equally supported

**Table 2: The important clinical questions related to blood pressure interpretation with the recommendations based on the level of evidence:**

The Clinical questions	The answer from evidence	Recommendation	Level of evidence
At what blood pressure do infants experience adverse clinical outcomes?	There is no known cut limit for low BP to predict clinical outcomes.	It is unknown if a specific low pressure is independently and causatively associated with adverse clinical outcomes in the given clinical context, except for transitional hypotension, where it may not be the determinant of outcomes. At present, therapeutic blood pressure thresholds should be individualized and taken in the context of clinical illness severity.	<b>1C</b> (2) (3)
Should we consider MBP < GA as a reliable determinant of clinically significant hypotension? Cut-off value?	MBP may be in the normal range in conditions associated with vasoconstrictive physiology. There is conflicting data on its relevance to predicting short and long-term outcomes, even in transitional hypotension. MBP < GA is not a valid definition of hypotension other than for transitional hypotension of prematurity.	Mean BP < GA should not be an operational definition for initiating therapeutic intervention in premature neonates beyond transitional hypotension.	<b>1C</b> (4) (2,3,5,6)
What is the most reliable reference for BP values?	While normative values have been well published, there is some discrepancy between studies on methodological heterogeneity.	The best available population-based blood pressure centile tables from published studies are included with these guidelines. While these may be used clinically to determine accepted normal ranges, providers should be aware of the limitations of available data.	<b>1C</b> (7) (8) (9) (10)
Invasive vs. noninvasive blood pressure monitoring?	The 2 methods correlate well for MBP, however, SBP is overestimated by the	Intra-aretrial BP monitoring should be the preferred method	<b>1C</b> (11)



	<p>oscillometric method compared to intra-arterial systolic BP. The upper limbs provide the most accurate and least variable location for oscillometric BP measurements. The bladder cuff width should be approximately 50% of the infant's mid-arm circumference.</p>	<p>for unstable infants whenever feasible. If oscillometric BP has to be used, upper limbs should be preferred over lower limbs, and monitoring should be frequent (e.g., 10-15 minutes) until the patient is stabilized.</p>	
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**POPULATION BASED BLOOD PRESSURE DATA OF PRETERM INFANTS****I. BLOOD PRESSURE DATA OF PRETERM INFANTS**

## Introduction:

Although there is no established gold standard data to define normal blood pressure values in preterm infants across the gestational and postnatal ages, we searched for the best available evidence. We selected the tables provided in this document for operational utilization. These data are already in use across several centers in Canada and have informed previous studies related to the assessment of hemodynamic instability in preterm infants. Considering the limitations of relying solely on blood pressures and their variability over time, it is strongly suggested for these data to be used in the clinical context and along with clinical correlation with other parameters indicative of hemodynamic stability and end-organ perfusion. Monitoring the trend of changes in blood pressure over time is recommended to be of higher clinical value than relying on and formulating decisions based on single values interpreted to be abnormal.

## Important considerations for interpreting enclosed tables:

1. The reference study for blood pressure variables in preterm infants recognized only stable infants.
2. Sick and unstable infants requiring cardiovascular medications were excluded from the study of the normalized blood pressure values; however, the reported blood pressure values were not correlated with long-term outcomes.
3. The study differentiates the day one table from beyond, 608 infants from 14 NICU, 21 % < 29 weeks at birth. The study team followed 9911 admission days, from 22 to 46 (postmenstrual age).
4. Although antenatal steroids were used during the study years, delayed cord clamping was not practiced. This may affect the interpretation of these normative data values in the current era.
5. Non-invasive BP measurements were taken using an appropriate-sized BP cuff, measured by two nurses trained to do measurements for all populations at three fixed times every day for the first 90 days of age.



GA	Systolic			Diastolic			Mean(Calculated)			Pulse pressure (Calculated)		
	95 <sup>th</sup> CI	Mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	Mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	mean	5 <sup>th</sup> CI
22	55	39	22	31	23	14	39	28	17	18	12	8
23	56	40	23	32	24	15	40	29	18	18	12	8
24	57	42	25	33	25	16	41	31	19	18	12	8
25	58	43	26	34	26	17	42	32	20	18	12	8
26	60	44	27	35	27	18	43	33	21	18	12	8
27	61	45	29	36	28	19	44	34	22	18	12	8
28	63	47	31	37	29	20	46	35	24	19	13	9
29	64	48	33	38	30	21	47	36	25	19	13	9
30	66	50	35	39	31	22	48	37	26	19	13	9
31	68	51	36	40	32	23	49	38	27	20	14	10
32	69	52	37	41	33	24	50	39	28	20	14	10
33	70	53	38	42	34	25	51	40	29	20	14	10
34	71	55	40	43	35	26	52	42	31	20	14	10
35	73	57	41	44	36	27	54	43	32	20	14	10
36	75	59	42	45	37	28	55	44	33	20	14	10
37	76	60	44	46	38	29	56	45	34	20	14	10
38	77	61	46	47	39	30	57	46	35	21	15	12
39	79	62	47	48	40	31	58	47	36	21	15	12
40	81	64	48	49	41	32	60	49	37	21	15	12
41	82	65	50	50	42	33	61	50	39	22	15	12
42	84	67	51	51	43	34	62	51	40	22	15	12

Table 1: Blood Pressure Values by Gestational Age (at birth) for Day One of Age \*

**Table 2 : Blood Pressure Values by Corrected Post Conceptional Age \***

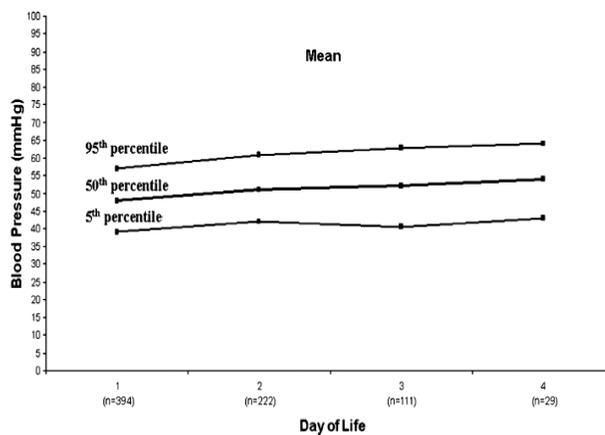
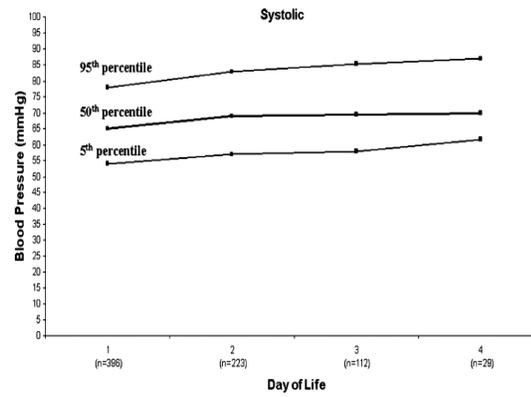
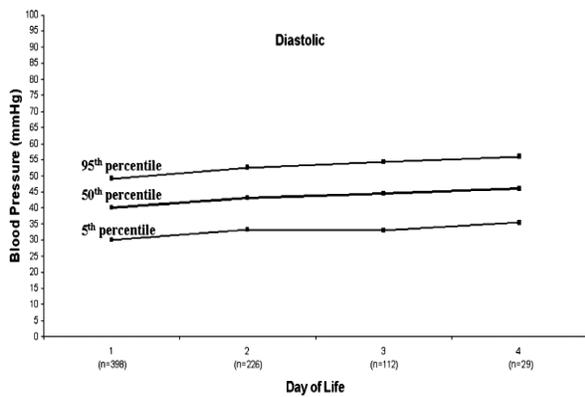
age	Systolic			Diastolic			Mean(Calculated)			Pulse pressure (Calculated)		
	95 <sup>th</sup> CI	Mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	Mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	mean	5 <sup>th</sup> CI	95 <sup>th</sup> CI	mean	5 <sup>th</sup> CI
<b>24</b>	68	49	33	46	29	14	53	36	20	25	16	12
<b>25</b>	69	51	36	47	30	15	54	37	22	25	16	12
<b>26</b>	70	52	38	48	31	17	55	38	24	25	16	14
<b>27</b>	71	54	40	49	32	18	56	39	25	25	16	14
<b>28</b>	72	55	41	50	33	19	57	40	26	27	17	15
<b>29</b>	73	56	42	51	34	20	58	41	27	27	17	15
<b>30</b>	75	59	43	52	35	21	60	43	28	28	18	15
<b>31</b>	78	61	46	53	36	22	61	44	30	28	20	17
<b>32</b>	80	62	48	54	37	23	63	45	31	28	20	17
<b>33</b>	81	63	50	55	38	24	64	46	33	28	20	17
<b>34</b>	83	66	51	56	39	25	65	48	34	30	21	18
<b>35</b>	84	69	52	57	40	26	66	50	35	30	21	18
<b>36</b>	87	71	55	58	41	27	68	51	36	30	22	18
<b>37</b>	89	72	57	59	42	28	69	52	38	30	22	18
<b>38</b>	90	75	59	60	43	29	70	54	39	30	22	18
<b>39</b>	91	78	60	60	44	30	70	55	40	30	22	18
<b>40</b>	92	80	61	61	44	30	71	56	40	33	25	20
<b>41</b>	93	81	62	62	46	31	72	58	41	33	25	20
<b>42</b>	95	82	63	63	47	32	74	59	42	33	25	20
<b>43</b>	97	83	65	64	48	33	75	60	44	33	25	20
<b>44</b>	98	86	67	65	49	34	76	61	45	33	25	20
<b>45</b>	100	88	69	66	50	35	77	63	46	33	25	20
<b>46</b>	102	89	71	66	51	36	78	64	48	33	25	21

\*Data from table 1 and 2 extracted from:

Zubrow AB(1), Hulman S, Kushner H FB. Determinants of blood pressure in infants admitted to neonatal intensive care units: a prospective multicenter study. Philadelphia Neonatal Blood Pressure Study Group. p. J of perinatology 1995, (6):470-9

## II. BLOOD PRESSURE DATA OF FULL-TERM INFANTS DURING THE FIRST 4 DAYS OF AGE\*

Age (days)	Systolic BP			Diastolic BP			Mean BP		
	95 <sup>th</sup> centile	50 <sup>th</sup> centile	5 <sup>th</sup> centile	95 <sup>th</sup> centile	50 <sup>th</sup> centile	5 <sup>th</sup> centile	95 <sup>th</sup> centile	50 <sup>th</sup> centile	5 <sup>th</sup> centile
1	77	65	53	50	40	30	57	48	38
2	83	68	56	52	41	31	58	51	38
3	85	69	58	53	42	32	60	52	39
4	86	70	60	54	43	33	60	53	40



\*Allison Kent, Zsuzsoka Kecskes, Bruce Shadbolt, Michale Falk, et al. blood pressure in the first year of life in healthy term infant's *Pediatr Nephrol* (2007) 22:1335–1341 1337

- Data derived from 406 stable full-term infants with gestational age 37-42 weeks.

- Exclusions: Maternal preeclampsia, hypertension, diabetes and illicit substance use, neonatal congenital/chromosomal anomaly or suspected sepsis.
- Non-invasive BP measurements were taken using an appropriate-sized BP cuff (inflatable proportion of the cuff encircling  $\geq 75\%$  of the limb circumference and the length of the cuff  $\geq$  two thirds of the length of the upper limb) on an upper limb, with the infant in a resting state, awake or asleep.

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