

Normative Blood Pressure Data for Indian Neonates

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Received: September 01, 2014; Initial review: January 02, 2015; Accepted: May 29, 2015

Objective: To establish the normative blood pressure (BP) values in healthy Indian neonates using oscillometric method, and to develop BP percentile charts.

Design: Prospective observational study.

Setting: Neonatal unit of a teaching hospital in Eastern India.

Participants: 1617 hemodynamically stable inborn neonates without birth asphyxia, major congenital anomaly, maternal complications (e.g. preeclampsia, hypertension, diabetes) or critical neonatal illness.

Procedure: Quite state measurements of systolic BP (SBP), diastolic BP (DBP) and mean arterial pressure (MAP) were

recorded by oscillometric method on day 4, 7 and 14 of postnatal life. The averages of three readings at 2-minute intervals were used.

Results: Percentile charts (providing 5th, 10th, 25th, 50th, 75th, 95th, and 99th percentile values) have been developed. SBP, DBP and MAP showed a steady rise from day 4 to day 14, and were comparable between males and females, but were significantly lower in preterms than in term neonates

Conclusions: Normative neonatal BP data along with gestational age-wise percentile charts shall be of help for decision-making and planning for sick newborns.

Keywords: Blood pressure, Hypertension, Neonate, Normogram.

Neonatal hypotension and hypertension require early detection and timely management due to possible association with short and long term adverse outcomes [1]. Blood pressure (BP) increases with birth weight, and gestational and chronological age [2]. However, there is paucity of studies documenting normative blood pressure values in healthy term and preterm neonates in India. Invasive BP monitoring, even though more accurate; is associated with complications such as infection, vasospasm and thrombus formation [3-5]. Indirect methods have been shown to be reliable and consistent if conducted under standardized conditions [6]. Studies evaluating normal BP ranges for normal, low birth weight (LBW) and very low birth weight (VLBW) infants have drawbacks of small sample size, retrospective data collection, infrequent measurements, or inclusion of infants on inotropes or with cerebral injury [1,7,8]. We planned this study to generate normative BP readings of healthy Indian neonates.

METHODS

This prospective observational study was conducted on healthy term and preterm newborns delivered in a

teaching hospital from September 2013 to April 2014 in Kolkata, India. The study protocol was approved by the Institutional Ethics Committee.

Enrolment was done on 3 days in a week (Monday, Wednesday and Friday). All healthy newborns were enrolled after birth on the scheduled days after obtaining written informed consent from the parent. Exclusion criteria included birth asphyxia; infants of mothers with hypertension, preeclampsia, gestational diabetes, type 1 diabetes mellitus or illicit substance use; major congenital anomaly; and sepsis or other problems requiring admission to neonatal intensive care unit (NICU), except for those preterm neonates admitted only for establishment of feeding. Each neonate was studied on day 4, 7, and 14 of birth. If discharged prior to day 14, the mother was asked to come for follow-up on the scheduled day.

Multichannel monitor (Larson and Turbo make; Star 55) was used to determine systolic BP (SBP), diastolic BP (DBP), and mean arterial pressure (MAP) by oscillometric method. Disposable infant BP cuffs (sizes 6-11 cm, 4-6 cm and 1-4 cm) were used. The smallest cuff size that covered at least two-thirds of the right upper arm

length and encompassed the entire arm circumference was selected. One investigator performed all BP measurements using a standardized protocol [9]. The appropriate-sized cuff was applied to the right upper arm with baby in prone position. Three successive BP recordings were taken at 2-minute intervals. The average of these three readings, rounded off to the nearest mmHg, was calculated and recorded for further analysis. The tasks of feeding the babies, applying an appropriate BP cuff and keeping them in prone position were done by the trained nursing staff. The doctor was involved in checking the preparatory work and recording the BP. Mean, standard deviation (SD), 95% confidence interval (CI), and 5th, 10th, 25th, 50th, 75th, 95th and 99th percentile values were calculated for the whole group. Statistica version 6 (Tulsa, Oklahoma: StatSoft Inc., 2001) and MedCalc version 11.6 (Mariakerke, Belgium: MedCalc Software 2011) softwares were used for statistical analysis.

RESULTS

From the 2055 neonates screened, data of 1617 (916 males) were available for analysis. **Fig. 1** shows the flow chart for the study participants. Of the 1617 analyzed, 97 had some missing data (86 babies present on day 7 but absent on day 14; 11 absent on day 7 but present on day

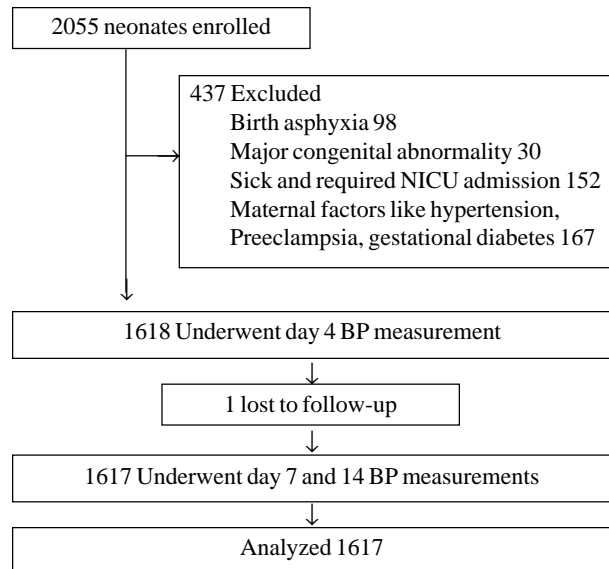


FIG. 1 Flow chart for the study participants.

14). There were 1427 term (1412 appropriate for gestational age [AGA]) and 190 preterm (186 AGA) newborns. The of BP recordings on days 4, 7 and 14 for term and preterm neonates have been presented in **Table I** along with the percentile values on the respective days.

TABLE I OSCILLOMETRIC NEONATAL BLOOD PRESSURE (mmHg) STRATIFIED BY GESTATIONAL STATUS (N=1617)

Parameter	Status	Mean (SD)	5 th	10 th	25 th	50 th	75 th	90 th	95 th	99 th
Day 4-SBP	Term	74 (7)	62	64	68	74	78	82	84	88
	Preterm	62 (7)	46	54	58	62	66	72	74	78
DBP	Term	54 (7)	42	43	50	54	60	62	62	66
	Preterm	43 (6)	32	34	40	42	47	50	52	56
MAP	Term	61 (6)	48	50	56	60	66	68	70	73
	Preterm	49 (6)	38	41	46	48	53	56	58	62
Day 7-SBP	Term	78 (6)	66	70	74	78	82	84	87	90
	Preterm	66 (7)	54	58	62	66	70	74	77	82
DBP	Term	58 (6)	50	50	55	60	62	64	66	72
	Preterm	47 (6)	38	40	42	48	50	55	56	62
MAP	Term	64 (5)	54	56	61	66	68	70	72	75
	Preterm	53 (5)	44	46	50	54	57	60	63	66
Day 14-SBP	Term	81 (5)	72	74	78	82	84	88	90	90
	Preterm	70 (7)	60	61	66	70	75	78	80	85
DBP	Term	61 (6)	52	54	60	60	64	68	70	74
	Preterm	51 (6)	40	42	50	50	55	60	60	62
MAP	Term	68 (5)	58	61	66	68	71	74	75	79
	Preterm	58 (6)	47	49	56	57	61	66	66	68

SBP = Systolic blood pressure; DBP = Diastolic blood pressure; MAP = Mean arterial pressure.

TABLE II OSCILLOMETRIC NEONATAL BLOOD PRESSURE RECORDINGS STRATIFIED BY GESTATIONAL AGE (WEEKS) AT BIRTH

Week	BP Percentile	Day-4			Day-7			Day-14		
		SBP	DBP	MAP	SBP	DBP	MAP	SBP	DBP	MAP
32	10	50	32	41	55	40	45	60	40	48
	50	58	40	46	62	42	50	68	50	56
	90	68	50	54	72	52	59	75	55	61
	95	77	50	56	74	55	59	75	56	62
	99	78	56	58	74	56	61	76	58	64
33	10	54	35	43	61	40	48	62	42	49
	50	64	42	48	68	45	52	68	50	56
	90	74	51	56	74	52	59	78	58	64
	95	77	52	56	78	55	60	78	58	64
	99	82	58	66	80	60	66	82	58	66
34	10	55	30	41	60	40	48	62	44	50
	50	62	42	48	65	48	53	68	50	56
	90	70	48	53	72	52	58	76	55	62
	95	78	50	56	74	54	59	78	58	64
	99	78	55	61	78	58	64	82	60	67
35	10	59	38	45	62	42	50	68	48	55
	50	64	44	50	68	50	56	73	52	59
	90	69	51	56	74	54	60	78	58	64
	95	72	52	56	76	55	61	78	60	66
	99	74	58	62	78	62	66	78	62	67
36	10	55	40	46	62	42	50	65	50	56
	50	66	44	51	68	50	57	74	55	60
	90	75	52	59	78	56	63	80	62	66
	95	76	55	61	78	58	64	82	62	68
	99	77	55	62	82	62	66	86	65	68
37	10	62	42	49	68	50	56	74	52	60
	50	72	52	58	76	56	62	78	60	66
	90	80	60	66	82	62	68	88	62	69
	95	82	62	66	85	62	68	88	68	73
	99	84	64	70	87	68	74	90	72	77
38	10	64	47	53	70	52	58	74	54	61
	50	73	53	60	78	58	65	80	60	67
	90	79	62	66	84	62	69	86	66	72
	95	82	62	67	84	64	70	88	68	74
	99	84	66	72	88	68	74	90	72	76
39	10	66	44	51	70	50	58	74	55	61
	50	76	54	61	78	60	66	82	60	68
	90	82	62	67	84	62	69	88	68	73
	95	84	62	68	86	66	72	90	70	75
	99	88	66	72	90	72	74	92	75	80
40	10	68	50	56	72	53	60	78	58	64
	50	77	58	64	82	60	68	84	64	70
	90	84	62	70	87	66	72	90	70	75
	95	87	64	70	88	68	74	90	70	76
	99	88	68	74	90	72	77	90	76	81

WHAT IS ALREADY KNOWN?

- Normal blood pressure data for neonates are available from other countries.

WHAT THIS STUDY ADDS?

- Normative blood pressure data with gestational age-wise percentile charts from Indian newborns is provided.

There were no statistically significant difference in mean SBP, DBP and MAP recordings between males and females. However, all three parameters were significantly lower in preterms compared to term neonates on each of the three days.

Table II presents BP data for days 4, 7 and 14 by gestational age, from 32nd to 40th week.

DISCUSSION

These gestational age-wise percentile charts for Indian newborns are likely to be of help in NICU settings for bedside decision-making, and for management of sick neonates. The limitations of the study include small sample size for preterm and SGA neonates. All the recordings were done by a single observer. Although single observer eliminates the possibility of interobserver variation, it increases the chances of erroneous result if this observer keeps on making a systematic error.

In our study, the median values of SBP, DBP and MAP on day 4 of life were comparable to those found by Kent, *et al.* [10] in Australian term newborns. The day-wise increment in MAP as seen in our study was also reported by Cunningham, *et al.* [11]. Kent, *et al.* [12] in 2009 reported normative BP data in 147 non-ventilated preterm neonates, and showed that the BP in preterm neonates was comparable to that of term infants, after two weeks. However, analysis of data from 566 preterm neonates in southern Cleveland [13] showed that BP in preterms continues to rise after 10 days of life, and stabilizes by a postconceptional age of 44-48 weeks. A higher value of DBP recorded in our study could be possibly due to the influence of higher rates of vaginal delivery, intrauterine growth retardation and maternal steroid injections, which were taken into consideration [14-16]. Higher DBP at the end of 2nd week with drop in DBP in the subsequent weeks has been reported earlier [17]. Follow-up blood pressure data in these neonates was not collected.

We conclude that the data derived from this study can be used to diagnose hypotension and hypertension in Indian newborns and monitor blood pressure of sick neonates.

Contributors: MS, SR, RM, DS, TS, DRC: diagnosis and management of the patients; RM, MS, CK, TS: searched the literature; RM, MS, AH: drafted the manuscript; MS, CK, AH, RM: critical review. All the authors approved the final version.
Funding: None; **Competing interests:** None stated.

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