

Blood Pressure and Heart Rate Monitoring in Children

Information Sheet for Primary Care Prescribers

I. Blood Pressure

Manual blood pressure measurement using a sphygmomanometer is the gold standard in children, with direct arterial BP measuring in neonates. Blood pressure may be measured using an automated oscillometric device or a manual cuff and auscultation. Oscillometric devices may overestimate blood pressure so any high blood pressure measured this way should be checked manually.

There are a number of basic principles that should be adhered to regardless of method used to measure.

Action	Rationale
Whenever possible the child should be rested for 3 minutes before each measurement.	Activity elevates heart rate and blood pressure and will lead to inaccurate reading.
Ensure the child is comfortable, with the limb used for measurement resting at heart level.	If the child is uncomfortable it can increase heart rate and blood pressure, and will lead to an inaccurate reading.
The bladder in the cuff used should encircle 80-100% of the limb circumference (this is often indicated by a range guide on the cuff itself). The widest cuff available should be used. A selection of cuffs must be available.	A cuff that is too small will give a false high reading, and a cuff that is too large will give a false low.
When possible the same limb, cuff and method of measurement should be used each time. Therefore it is important for this information to be clearly documented.	For blood pressure readings to be comparable with each other the same method and equipment is needed.
Always leave at least one minute between each reading.	This enables the child to settle and become calm, to promote the accuracy of the reading.

Normal blood pressure readings for children

Children's blood pressure increases with size. The most accurate way of measuring blood pressure is comparing readings based upon the child's height, using the normal growth charts to determine the child's percentile ([See appendix 1](#)). A child would be considered to be normotensive if their blood pressure is at the 90th percentile or less.

Table 1: Definitions of BP Categories and Stages

For Children Aged 1–13 y	For Children Aged ≥13 y
Normal BP: <90th percentile	Normal BP: <120/<80 mm Hg
Elevated BP: ≥90th percentile to <95th percentile or 120/80 mm Hg to <95th percentile (whichever is lower)	Elevated BP: 120/<80 to 129/<80 mm Hg
Stage 1 HTN: ≥95th percentile to <95th percentile + 12 mmHg, or 130/80 to 139/89 mm Hg (whichever is lower)	Stage 1 HTN: 130/80 to 139/89 mm Hg
Stage 2 HTN: ≥95th percentile + 12 mmHg, or ≥140/90 mm Hg (whichever is lower)	Stage 2 HTN: ≥140/90 mm Hg

Table 2: Management

<u>Asymptomatic hypertension</u> : Average SBP $\geq 95^{\text{th}}$ to $95^{\text{th}} + 12\text{mmHg}$, or for children aged 13 and over, 130/80 to 139/89 systolic	Investigate and lifestyle advice. Treat as per hypertension guideline in paediatric patients . Recheck the BP in 1 to 2 weeks by auscultation (manual) . If still at the stage 1 HTN level , upper and lower extremity BP should be checked (right arm, left arm and 1 leg) and BP should be rechecked in 3 months. Refer as appropriate.
<u>Symptomatic hypertension and/or acute severe hypertension</u> : Average SBP of $\geq 95^{\text{th}}$ centile + 12mmHg or $\geq 140/90$ (whichever is lowest)	Refer for hospital admission. Refer to paediatric hypertension specialist if blood pressure is consistently above the 95^{th} centile of age and height.
<u>Hypertensive crisis</u> : seizures, encephalopathy or cardiac failure	Require admission to an HDU or PICU setting

Table 3: Blood pressure measurement using an automated monitor

Action	Rationale
1. Place the appropriate cuff on the child's limb, ensuring artery indicator is placed over the artery to be used for the measurement.	To ensure an accurate reading is obtained.
The right arm should be used whenever possible. However, if this limb is injured or has a cannula in situ it should not be used.	
2. Switch on machine, and if possible set for 30mmHg above expected systolic pressure. This can be changed on many models.	This will increase the accuracy of the reading, enabling the machine to detect the oscillations in pressure accurately.
3. Press the machine to start, ensuring that the child is comfortable and the limb is supported.	
4. Remove cuff	To make the child comfortable
5. Readings should be recorded accurately to 2mmHg, not rounded to the nearest value.	Rounding off to the nearest 5-10mmHg can result in an inaccurate reading affecting treatment decisions.

II. Heart Rate

Reference ranges for heart rate in children is summarised [here](#). Management of heart rate above 180 bpm in children can be found on [Supraventricular Tachycardia guideline](#).

References:

1. Flynn JT, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. *Pediatrics*. 2017;140(3):e20171904
2. Great Ormond Street Hospital for Children. [Appendix 4 Normal Heart Rates](#). 2020. [Online]. Accessed on 12/08/2020.
3. Josep Brugada, et.al, Pharmacological and non-pharmacological therapy for arrhythmias in the pediatric population: EHRA and AEPC-Arrhythmia Working Group joint consensus statement, *EP Europace*, Volume 15, Issue 9, September 2013, Pages 1337–1382, <https://doi.org/10.1093/europace/eut082>
4. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004;114(2 Suppl 4th Report):555-576.
5. Nottingham University Hospitals. Guideline for the assessment and management of Hypertension in Paediatric Patients. August 2020.
6. Nottingham University Hospitals. Guideline for the Management of Supraventricular Tachycardia in Children and Young People. June 2020.
7. Royal College of Nursing. Standards for Assessing, Measuring and Monitoring Vital Signs in Infants, Children and Young People. Royal College of Nursing, London. May 2020. [Online]. Accessed on 12/08/2020. www.rcn.org.uk

Appendix 1: Blood pressure centiles by gender, age and height centile

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5 th	10 th	25 th	50 th	75 th	90 th	95 th	5 th	10 th	25 th	50 th	75 th	90 th	95 th
1	50 th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
	90 th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
	95 th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
	95 th + 12 mmHg	114	114	115	115	116	117	117	66	66	67	67	68	69	69
2	50 th	87	87	88	89	89	90	91	43	43	44	44	45	46	46
	90 th	100	100	101	102	103	103	104	55	55	56	56	57	58	58
	95 th	104	105	105	106	107	107	108	57	58	58	59	60	61	61
	95 th + 12 mmHg	116	117	117	118	119	119	120	69	70	70	71	72	73	73
3	50 th	88	89	89	90	91	92	92	45	46	46	47	48	49	49
	90 th	101	102	102	103	104	105	105	58	58	59	59	60	61	61
	95 th	106	106	107	107	108	109	109	60	61	61	62	63	64	64
	95 th + 12 mmHg	118	118	119	119	120	121	121	72	73	73	74	75	76	76
4	50 th	90	90	91	92	93	94	94	48	49	49	50	51	52	52
	90 th	102	103	104	105	105	106	107	60	61	62	62	63	64	64
	95 th	107	107	108	108	109	110	110	63	64	65	66	67	67	68
	95 th + 12 mmHg	119	119	120	120	121	122	122	75	76	77	78	79	79	80
5	50 th	91	92	93	94	95	96	96	51	51	52	53	54	55	55
	90 th	103	104	105	106	107	108	108	63	64	65	65	66	67	67
	95 th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95 th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
6	50 th	93	93	94	95	96	97	98	54	54	55	56	57	57	58
	90 th	105	105	106	107	109	110	110	66	66	67	68	68	69	69
	95 th	108	109	110	111	112	113	114	69	70	70	71	72	72	73
	95 th + 12 mmHg	120	121	122	123	124	125	126	81	82	82	83	84	84	85
7	50 th	94	94	95	97	98	98	99	56	56	57	58	58	59	59
	90 th	106	107	108	109	110	111	111	68	68	69	70	70	71	71
	95 th	110	110	111	112	114	115	116	71	71	72	73	73	74	74
	95 th + 12 mmHg	122	122	123	124	126	127	128	83	83	84	85	85	86	86
8	50 th	95	96	97	98	99	99	100	57	57	58	59	59	60	60
	90 th	107	108	109	110	111	112	112	69	70	70	71	72	72	73
	95 th	111	112	112	114	115	116	117	72	73	73	74	75	75	75
	95 th + 12 mmHg	123	124	124	126	127	128	129	84	85	85	86	87	87	87
9	50 th	96	97	98	99	100	101	101	57	58	59	60	61	62	62
	90 th	107	108	109	110	112	113	114	70	71	72	73	74	74	74
	95 th	112	112	113	115	116	118	119	74	74	75	76	76	77	77
	95 th + 12 mmHg	124	124	125	127	128	130	131	86	86	87	88	88	89	89
10	50 th	97	98	99	100	101	102	103	59	60	61	62	63	63	64
	90 th	108	109	111	112	113	115	116	72	73	74	74	75	75	76
	95 th	112	113	114	116	118	120	121	76	76	77	77	78	78	78
	95 th + 12 mmHg	124	125	126	128	130	132	133	88	88	89	89	90	90	90
11	50 th	99	99	101	102	103	104	106	61	61	62	63	63	63	63
	90 th	110	111	112	114	116	117	118	74	74	75	75	75	76	76
	95 th	114	114	116	118	120	123	124	77	78	78	78	78	78	78
	95 th + 12 mmHg	126	126	128	130	132	135	136	89	90	90	90	90	90	90
12	50 th	101	101	102	104	106	108	109	61	62	62	62	62	63	63
	90 th	113	114	115	117	119	121	122	75	75	75	75	75	76	76
	95 th	116	117	118	121	124	126	128	78	78	78	78	78	79	79
	95 th + 12 mmHg	128	129	130	133	136	138	140	90	90	90	90	90	91	91
13	50 th	103	104	105	108	110	111	112	61	61	61	62	63	64	65
	90 th	115	116	118	121	124	126	126	74	74	74	75	76	77	77
	95 th	119	120	122	125	128	130	131	78	78	78	78	80	81	81
	95 th + 12 mmHg	131	132	134	137	140	142	143	90	90	90	90	92	93	93
14	50 th	105	106	109	111	112	113	113	60	60	62	64	65	66	67
	90 th	119	120	123	126	127	128	129	74	74	75	77	78	79	80
	95 th	123	125	127	130	132	133	134	77	78	79	81	82	83	84
	95 th + 12 mmHg	135	137	139	142	144	145	146	89	90	91	93	94	95	96
15	50 th	108	110	112	113	114	114	114	61	62	64	65	66	67	68
	90 th	123	124	126	128	129	130	130	75	76	78	79	80	81	81
	95 th	127	129	131	132	134	135	135	78	79	81	83	84	85	85
	95 th + 12 mmHg	139	141	143	144	146	147	147	90	91	93	95	96	97	97
16	50 th	111	112	114	115	115	116	116	63	64	66	67	68	69	69
	90 th	126	127	128	129	131	131	132	77	78	79	80	81	82	82
	95 th	130	131	133	134	135	136	137	80	81	83	84	85	86	86
	95 th + 12 mmHg	142	143	145	146	147	148	149	92	93	95	96	97	98	98
17	50 th	114	115	116	117	117	118	118	65	66	67	68	69	70	70
	90 th	128	129	130	131	132	133	134	78	79	80	81	82	82	83
	95 th	132	133	134	135	137	138	138	81	82	84	85	86	86	87
	95 th + 12 mmHg	144	145	146	147	149	150	150	93	94	96	97	98	98	99

Use percentile values to stage BP readings. The 50th, 90th, and 95th percentiles were derived by using quantile regression on the basis of normal-weight children (BMI <85th percentile).

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5 th	10 th	25 th	50 th	75 th	90 th	95 th	5 th	10 th	25 th	50 th	75 th	90 th	95 th
1	50 th	84	85	86	86	87	88	88	41	42	42	43	44	45	46
	90 th	98	99	99	100	101	102	102	54	55	56	56	57	58	58
	95 th	101	102	102	103	104	105	105	59	59	60	60	61	62	62
	95 th + 12 mmHg	113	114	114	115	116	117	117	71	71	72	72	73	74	74
2	50 th	87	87	88	89	90	91	91	45	46	47	48	49	50	51
	90 th	101	101	102	103	104	105	106	58	58	59	60	61	62	62
	95 th	104	105	106	106	107	108	109	62	63	63	64	65	66	66
	95 th + 12 mmHg	116	117	118	118	119	120	121	74	75	75	76	77	78	78
3	50 th	88	89	89	90	91	92	93	48	48	49	50	51	53	53
	90 th	102	103	104	104	105	106	107	60	61	61	62	63	64	65
	95 th	106	106	107	108	109	110	110	64	65	65	66	67	68	69
	95 th + 12 mmHg	118	118	119	120	121	122	122	76	77	77	78	79	80	81
4	50 th	89	90	91	92	93	94	94	50	51	51	53	54	55	55
	90 th	103	104	105	106	107	108	108	62	63	64	65	66	67	67
	95 th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95 th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
5	50 th	90	91	92	93	94	95	96	52	52	53	55	56	57	57
	90 th	104	105	106	107	108	109	110	64	65	66	67	68	69	70
	95 th	108	109	109	110	111	112	113	68	69	70	71	72	73	73
	95 th + 12 mmHg	120	121	121	122	123	124	125	80	81	82	83	84	85	85
6	50 th	92	92	93	94	96	97	97	54	54	55	56	57	58	59
	90 th	105	106	107	108	109	110	111	67	67	68	69	70	71	71
	95 th	109	109	110	111	112	113	114	70	71	72	72	73	74	74
	95 th + 12 mmHg	121	121	122	123	124	125	126	82	83	84	84	85	86	86
7	50 th	92	93	94	95	97	98	99	55	55	56	57	58	59	60
	90 th	106	106	107	109	110	111	112	68	68	69	70	71	72	72
	95 th	109	110	111	112	113	114	115	72	72	73	73	74	74	75
	95 th + 12 mmHg	121	122	123	124	125	126	127	84	84	85	85	86	86	87
8	50 th	93	94	95	97	98	99	100	56	56	57	59	60	61	61
	90 th	107	107	108	110	111	112	113	69	70	71	72	72	73	73
	95 th	110	111	112	113	115	116	117	72	73	74	74	75	75	75
	95 th + 12 mmHg	112	123	124	125	127	128	129	84	85	86	86	87	87	87
9	50 th	95	95	97	98	99	100	101	57	58	59	60	60	61	61
	90 th	108	108	109	111	112	113	114	71	71	72	73	73	73	73
	95 th	112	112	113	114	116	117	118	74	74	75	75	75	75	75
	95 th + 12 mmHg	124	124	125	126	128	129	130	86	86	87	87	87	87	87
10	50 th	96	97	98	99	101	102	103	58	59	59	60	61	61	62
	90 th	109	110	111	112	113	115	116	72	73	73	73	73	73	73
	95 th	113	114	114	116	117	119	120	75	75	76	76	76	76	76
	95 th + 12 mmHg	125	126	126	128	129	131	132	87	87	88	88	88	88	88
11	50 th	98	99	101	102	104	105	106	60	60	60	61	62	63	64
	90 th	111	112	113	114	116	118	120	74	74	74	74	74	75	75
	95 th	115	116	117	118	120	123	124	76	77	77	77	77	77	77
	95 th + 12 mmHg	127	128	129	130	132	135	136	88	89	89	89	89	89	89
12	50 th	102	102	104	105	107	108	108	61	61	61	62	64	65	65
	90 th	114	115	116	118	120	122	122	75	75	75	75	76	76	76
	95 th	118	119	120	122	124	125	126	78	78	78	78	79	79	79
	95 th + 12 mmHg	130	131	132	134	136	137	138	90	90	90	90	91	91	91
13	50 th	104	105	106	107	108	108	109	62	62	63	64	65	65	66
	90 th	116	117	119	121	122	123	123	75	75	75	76	76	76	76
	95 th	121	122	123	124	126	126	127	79	79	79	79	80	80	81
	95 th + 12 mmHg	133	134	135	136	138	138	139	91	91	91	91	92	92	93
14	50 th	105	106	107	108	109	109	109	63	63	64	65	66	66	66
	90 th	118	118	120	122	123	123	123	76	76	76	76	77	77	77
	95 th	123	123	124	125	126	127	127	80	80	80	80	81	81	82
	95 th + 12 mmHg	135	135	136	137	138	139	139	92	92	92	92	93	93	94
15	50 th	105	106	107	108	109	109	109	64	64	64	65	66	67	67
	90 th	118	119	121	122	123	123	124	76	76	76	77	77	78	78
	95 th	124	124	125	126	127	127	128	80	80	80	81	82	82	82
	95 th + 12 mmHg	136	136	137	138	139	139	140	92	92	92	93	94	94	94
16	50 th	106	107	108	109	109	110	110	64	64	65	66	66	67	67
	90 th	119	120	122	123	124	124	124	76	76	76	77	78	78	78
	95 th	124	125	125	127	127	128	128	80	80	80	81	82	82	82
	95 th + 12 mmHg	136	137	137	139	139	140	140	92	92	92	93	94	94	94
17	50 th	107	108	109	110	110	110	111	64	64	65	66	66	66	67
	90 th	120	121	123	124	124	125	125	76	76	77	77	78	78	78
	95 th	125	125	126	127	128	128	128	80	80	80	81	82	82	82
	95 th + 12 mmHg	137	137	138	139	140	140	140	92	92	92	93	94	94	94

Use percentile values to stage BP readings. The 50th, 90th, and 95th percentiles were derived by using quantile regression on the basis of normal-weight children (BMI <85th percentile).

Appendix 2: Normal Paediatric Heart Rate Ranges

Age	Guide weight (kg)		HR beats per minute 5 th – 95 th centile
	Boys	Girls	
Birth	3.5	3.5	120 – 170
1 month	4.5	4.5	
3 months	6.5	6	115 – 160
6 months	8	7	110 – 160
12 months	9.5	9	
18 months	11	10	100 – 155
2 years	12	12	100 – 150
3 years	14	14	90 – 140
4 years	16	16	80 – 135
5 years	18	18	
6 years	21	20	80 – 130
7 years	23	22	
8 years	25	25	70 – 120
9 years	28	28	
10 years	31	32	
11 years	35	35	
12 years	43	43	65 – 115
14 years	50	50	60 – 110

Appendix 3: Normal Heart Rates

<u>Normal heart rates in children</u>		
Age	Awake rate/min	Sleeping rate/min
Neonate	100-180	80-160
Infant (6 mo.)	100-160	75-160
Toddler	80-110	60-90
Pre-schooler	70-110	60-90
School-age	65-110	60-90
Adolescent	60-90	50-90

Version Control- Blood Pressure and Heart Rate Monitoring in Children			
Version	Author(s)	Date	Changes
1.1	Shary Walker	17/09/2020	
2	Laura Catt	July 2023	No change required