Hypertension & its management

(15 mins)

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Hypertension

Definition:

<16 years

Normal	<90th
High-normal	≥90th to <95th percentile
Hypertension	≥95th percentile
Stage 1 hypertension	95th percentile to the 99th percentile and 5 mmHg
Stage 2 hypertension	>99th percentile plus 5 mmHg
ISH	SBP ≥95th percentile and DBP <90th percentile

>16 years

Normal	<130/85
High-normal	130–139/85–89
Hypertension	≥140/90
Stage 1 hypertension	140–159/90–99
Stage 2 hypertension	160–179/100–109
ISH	≥140/<90

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Hypertension

Method of measuring Blood Pressure

- The Cuff:
  - Breadth to length ratio = 1: 2
  - Encircle 40% of circ / 80 – 100% in length

*BP is **overestimated due to a smaller cuff** rather than underestimated due to a larger cuff*

- Device:
  - Aneroid Sphygmomanometer is idea
  - Oscillometric device (tend to overestimate, measures mean BP, needs validation): Not truly ideal
  - Values >90th centile should be checked with auscultation

BP Normative Data

TABLE 2. Blood pressure for boys by age and height percentiles

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

TABLE 3. Blood pressure for girls by age and height percentiles

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

Modified from Task Force on High Blood Pressure in Children and Adolescents [7]. Boxed area corresponds to reference values of boys 16 years or older in which the reference values

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Hypertension

Out of office BP monitoring

Infants / young children (Doppler)

ADC Online First, published on June 9, 2012 as 10.1136/archdischild-2011-301160

Home Doppler blood pressure monitoring in infants and children: a pilot study of its feasibility and clinical utility

Joanna C Clothier, Emma Rigby, Manish D Sinha

Measurement of SBP at home by parents using hand-held Doppler device and aneroid sphygmomanometer: a single-centre experience

Joanna Newton[a], Cheentan Singh[b], and Manish D. Sinha[a,c]

Children >6 (ABPM)

TABLE 6. Systolic and diastolic ambulatory blood pressure (SBP/DBP) values for age (boys)

	Boys											
	24-h				Day				Night			
Age (years)	50th	75th	90th	95th	50th	75th	90th	95th	50th	75th	90th	95th
5	105/65	109/69	113/72	116/74	111/72	116/76	120/79	123/81	95/55	99/59	103/62	106/65
6	106/66	110/69	115/73	118/75	112/72	116/76	121/79	124/81	96/55	100/59	105/63	108/66
7	106/66	111/70	116/73	119/75	112/73	117/76	122/80	125/82	96/56	101/60	106/64	110/67
8	107/66	112/70	117/73	120/75	112/73	117/76	122/80	125/82	97/56	102/60	108/64	111/67
9	108/67	113/70	118/73	121/75	113/72	118/76	123/80	126/82	97/56	103/60	109/64	112/67
10	109/67	114/70	119/73	123/75	113/72	119/76	124/80	127/82	98/56	104/60	110/64	113/67
11	110/67	116/71	121/74	125/76	115/72	121/76	126/80	129/82	99/56	105/60	111/64	115/67
12	113/67	118/71	124/74	127/76	117/72	123/76	128/80	132/82	101/56	107/60	113/64	116/67
13	115/67	121/71	126/74	130/76	120/72	126/76	131/80	135/82	103/56	109/60	115/64	119/67
14	118/68	124/71	129/75	133/77	122/73	129/77	134/80	138/82	106/57	112/61	118/64	121/67
15	121/68	127/72	132/75	136/77	125/73	132/77	137/81	141/83	108/57	114/61	120/64	123/66
16	123/69	129/72	135/76	138/78	128/74	135/78	140/81	144/84	111/57	117/61	123/64	126/66

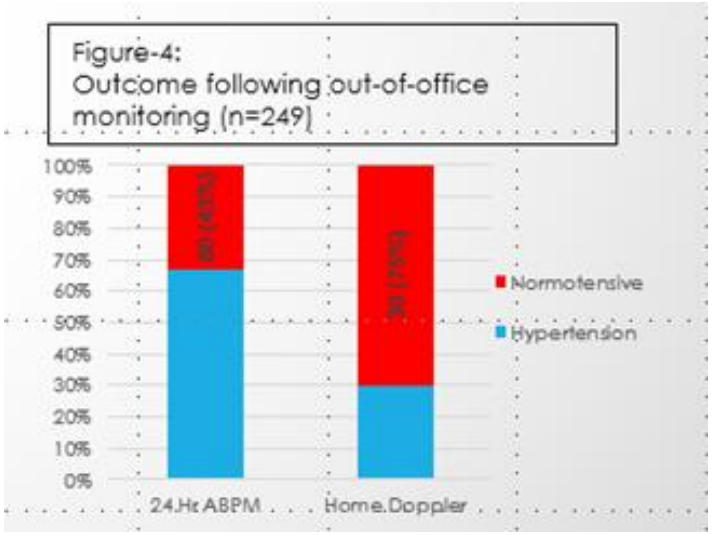
he values are in mmHg. Data from [183].

TABLE 7. Systolic and diastolic ambulatory blood pressure (SBP/DBP) values for age (girls)

	Girls											
	24-h				Day				Night			
Age (years)	50th	75th	90th	95th	50th	75th	90th	95th	50th	75th	90th	95th
5	103/66	108/69	112/72	115/74	108/73	114/77	118/80	121/82	95/56	100/61	105/66	108/69
6	104/66	109/69	114/72	116/74	110/73	115/77	120/80	122/82	96/56	101/61	106/65	110/68
7	105/66	110/69	115/72	118/74	111/72	116/77	121/80	123/82	96/56	102/60	107/65	111/67
8	107/66	112/69	116/72	119/74	112/72	117/76	122/80	124/82	97/55	103/60	108/64	112/67
9	108/66	113/70	117/73	120/74	112/72	118/76	122/80	125/82	98/55	103/59	109/64	112/67
10	109/66	114/70	118/73	121/75	113/72	119/76	123/79	126/81	98/55	104/59	110/64	113/67
11	110/66	115/70	119/73	122/75	114/72	120/76	124/79	127/81	99/54	105/59	110/63	114/66
12	111/67	116/70	120/74	123/76	115/72	121/76	125/80	128/82	100/54	105/59	110/63	114/66
13	112/67	117/71	121/74	124/76	116/72	122/77	126/80	129/82	101/54	106/59	111/63	114/66
14	113/67	118/71	122/74	125/76	118/73	123/77	127/80	130/82	101/55	106/59	111/63	114/65
15	114/68	118/71	123/75	125/77	119/73	124/77	128/80	130/82	102/55	107/59	111/63	114/65
16	115/68	119/71	123/75	126/77	120/74	124/77	129/80	131/82	103/55	107/59	111/63	114/65

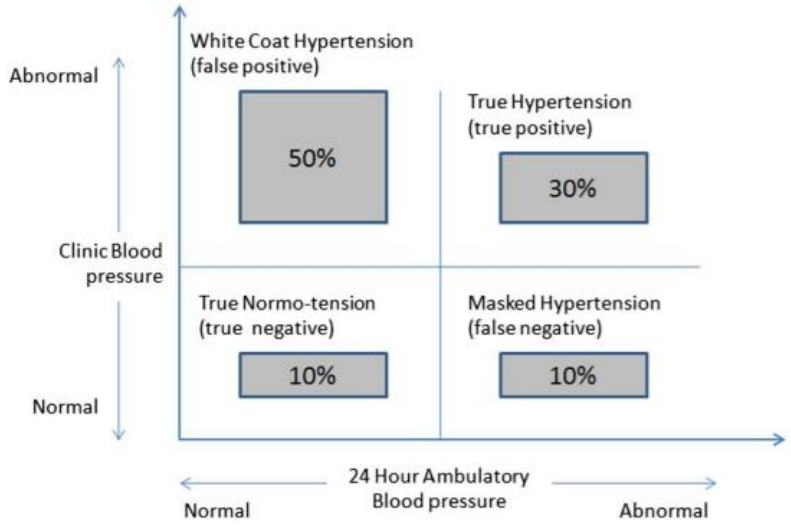
he values are in mmHg. Data from [183].

Hypertension



40% of referrals were deemed normotensive

Need for accurate method and multiple checks
Context / History / Other clinical findings



Presentation of hypertension in OP clinic

Systolic or Diastolic BP

- Systolic hypertension accounts for most hypertension
  - Isolated Systolic Hypertension: 80%; SDH: 10% and IDH: 10%
- Systolic hypertension accounts for the most untreated hypertension
  - in adults most important factor driving cardiac, renal and cerebral events
  - probably the same in high risk cohorts in children
- Currently we manage hypertension based on SBP primarily
  - Diastolic BP follows adult PHTN pattern

History

- pregnancy history including antenatal imaging, maternal health and drugs during pregnancy;
- neonatal history including prematurity, birth weight, history of umbilical vessel catheterisation, bronchopulmonary dysplasia and medications;
- other comorbidities including any cardiac or renal disease, medications, attention deficit hyperactivity disorder;
- history of feeding difficulties and sleep disturbance and snoring in older children;
- history of headaches, nausea, vomiting, epistaxis, abdominal pain, increasing tiredness or irritability;
- history of polydipsia, polyuria or history of urinary tract infections;
- diet overview—focus on calories and salt intake;
- family history of hypertension, heart disease, renal disease and stroke and
- level of physical activity.

Examination

- Neonates, infants and young children may present with congestive heart failure, shock or with irritability, failure to thrive, seizures, unexplained tachypnoea, apnoea or lethargy.
- Absent or difficult to palpate femoral pulses.
- Four-limb BP with discrepant upper limb >lower limb BP levels by >10 mm Hg.
- Clinical findings in keeping with possible causes of renovascular disease including neurofibromatosis type 1, Williams syndrome and Ehlers-Danlos syndrome.
- Short stature and hypertension may suggest chronic renal disease or other rare syndromes; excess weight is usually associated with increased height for age.
- Funduscopy for papilloedema and/or hypertensive vascular changes, retinal bleeding and cotton wool lesions.
- Abdominal mass or bruit.
- Any evidence of neurological deficit—sometimes lower motor neuron facial palsy.
- Findings in keeping with congestive cardiac failure.
- Evidence of thyroid or Cushing's disease.

Features of Hypertension

Red flags	End-organ dysfunction
Nausea and vomiting Headaches Upper motor neuron signs Hemiparesis or monoparesis, Bell's palsy Loss of vision or blurred vision Seizures Altered sensorium Drowsiness/reduced Glasgow Coma Scale	Hypertensive encephalopathy
Acute and chronic hypertensive changes on funduscopy Papilloedema	Hypertensive vascular changes, retinal bleeding and cotton wool lesions Increased intracranial pressure
Cardiomegaly Gallop rhythm Breathlessness Pulmonary oedema	Cardiac failure

Table 4 Causes of secondary hypertension during childhood

- Parenchymal renal disease
  - Glomerulonephritis
    - Post-infection
    - IgA nephropathy, Henoch-Schonlein purpura nephritis
    - Lupus nephritis
    - Anti-neutrophil cytoplasmic antibodies-associated nephritis
    - Anti-glomerular basement membrane nephritis
  - Focal and segmental glomerulosclerosis
  - Pyelonephritis-related renal scarring
  - Acute kidney injury with salt and water overload
  - Polycystic kidney disease
  - Chronic kidney disease
  - Obstructive uropathy
- Renovascular
  - Renal artery stenosis
    - Idiopathic
    - Fibromuscular dysplasia
    - Neurofibromatosis type 1
    - Williams syndrome
  - Mid-aortic syndrome
  - Thrombosis of renal artery or vein
  - Acute or post haemolytic uraemic syndrome
  - Fistulae
  - External compression
- Endocrine
  - Cortisol/glucocorticoid excess
  - Aldosterone/mineralocorticoid excess
  - Catecholamine excess
  - Congenital adrenal hyperplasia
  - Thyroid disease
- Cardiovascular
  - Coarctation of aorta
  - Takayasu arteritis
- Central nervous system
  - Pain
  - Convulsions
  - Increased intracranial pressure
  - Guillain-Barré syndrome
  - Dysautonomia
- Malignancy
  - Wilms' tumour (nephroblastoma)
  - Neuroblastoma
  - Pheochromocytoma
- Drugs
  - Amphetamine or sympathomimetics
  - Acute vitamin D intoxication, hypercalcemia
  - Calcineurin inhibitors (ciclosporin/tacrolimus)
  - Decongestants
  - Erythropoietin
  - Oral contraceptive pills
  - Steroids
  - Recent discontinuation of antihypertensive/s
- Others
  - Obstructive sleep apnoea
  - Bronchopulmonary dysplasia
  - Single gene defects causing hypertension (eg, Liddle's syndrome)

Investigations

Table 6 Investigation workup of children with hypertension

Investigations—recommended in all hypertensive cases	**Further investigations as indicated**
Urine dipstick for any protein and blood	Glomerulonephritis screen (eg, C3,C4, antinuclear antibody, ANCA)
Urine culture for infection	24-hour urine collection for sodium
Full blood count	Peripheral plasma renin and plasma aldosterone
Serum urea, creatinine and electrolytes	Plasma cortisol
Thyroid-stimulating hormone	Tc99 dimercaptosuccinic acid scan
Abdominal, renal and urinary tract ultrasound	Urine and plasma catecholamines or metanephrines
Echocardiography	Renal colour Doppler ultrasonography
Assessing comorbidities	Urinary steroid profile
Random urine microalbuminuria	Sleep study
Uric acid	MR angiography of abdominal aorta
Lipid profile (cholesterol- total, LDL, HDL and triglycerides)	CT angiography
Fasting glucose and n\haemoglobin A_{1c}	Metaiodobenzylguanidine scanning
Funduscopy	Digital subtraction angiography of abdominal aorta and renal vessels
	Selective renal vein renin measurement
	Genetic studies

Treatment

Non Pharmacological **Try for 3-6 months**	**Hypertensive Crisis / emergency** **IV : SNP, Labetalol, Hydralazine**	**Long term medication**
Lifestyle modification Aim for BMI <85th centile Salt restriction Exercise ~40 min (5/week) Reducing sedentary life	ABC **m/m @ PICU / Renal Unit** Calculate target BP ~90th centile. Aim for reduction; not more than 25% of target in first 6-8 hrs f/b remaining in next 24 – 48 hrs	Calcium Channel B Blocker ACE inhibitors AR Blockers Alpha blockers Diuretics Choice depends on Aetiology / Age/ Renal function / Co morbidity

Important references

- Singh C, Jones H, Copeman H*, et al* **Fifteen-minute consultation: the child with systemic arterial hypertension** *Archives of Disease in Childhood - Education and Practice* 2017;**102:**2-7.

- Lurbe E et al; **European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents.** J Hypertens. 2016 Oct;34(10):1887-920. doi: 10.1097/HJH.0000000000001039. PMID: 27467768

- Lurbe E et al; **Management of high blood pressure in children and adolescents: recommendations of the European Society of Hypertension**, Journal of Hypertension: September 2009 - Volume 27 - Issue 9 - p 1719-1742 doi: 10.1097/HJH.0b013e32832f4f6b

Many thanks…

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