OBJECTIVES

- Identify children and adolescents for whom hypertension screening is appropriate
- Implement an initial workup for pediatric hypertension
- Develop treatment plans for children with essential or secondary hypertension

INTRODUCTION

- Hypertension is a silent killer. It can be a primary disease (essential hypertension) or due to some underlying disease process (secondary hypertension) (more common in pediatric population)

- Blood pressure

  = systemic vascular resistance χ cardiac output. Factors increasing either of the two can increase BP.

DEFINITION

- Hypertension is defined as average SBP and/or diastolic BP that is ≥ 95th percentile for gender , age and height on 3 or more occasions.

CLASSIFICATION OF HYPERTENSION

- Normal — <90th percentile of SBP and /or DBP for the age gender and height
- Prehypertension — 90th to <95th percentile or if BP exceeds 120/80 even if <90th percentile upto 95th percentile
- Stage 1 hypertension — 95th to 99th percentile + 5mm Hg
- Stage 2 hypertension — >99percentile + 5mm Hg

- **White-coat hypertension**—A patient with BP levels above the 95th percentile in a physician's office or clinic who is normotensive outside a clinical setting. (Ambulatory BP monitoring is usually required to make this diagnosis.)

Which children should get their blood pressure checked?

- All children 3 years of age and older should have their blood pressure measured at all health care encounters, including both well child care and acute care or sick visits.

- Certain children younger than 3 with co morbid conditions:-
- History of prematurity
- History of low birth weight or neonatal intensive care unit (NICU) stay
- Presence of congenital heart disease, kidney disease, or genitourinary abnormality
- Family history of congenital kidney disease
- Recurrent urinary tract infection (UTI), hematuria, proteinuria

contd.

- Transplant of solid organ or bone marrow
- Malignancy
- Taking medications known to increase blood pressure (steroids, decongestants, nonsteroidal anti-inflammatory drugs [NSAIDs], beta-adrenergic agonists)
- Presence of systemic illness associated with hypertension (neurofibromatosis, tuberous sclerosis)
- Evidence of increased intracranial pressure

Blood Pressure Levels for Boys by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89	34	35	36	37	38	39	39
	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	50th	84	85	87	88	90	92	92	39	40	41	42	43	44	44
	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	50th	86	87	89	91	93	94	95	44	44	45	46	47	48	48
	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	50th	88	89	91	93	95	96	97	47	48	49	50	51	51	52
	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	50th	90	91	93	95	96	98	98	50	51	52	53	54	55	55
	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	50th	91	92	94	96	98	99	100	53	53	54	55	56	57	57
	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	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	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	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	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	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	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	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	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

Blood Pressure Levels for Boys by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	99	100	102	104	105	107	107	59	59	60	61	62	63	63
	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	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	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	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	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	50th	106	107	109	111	113	114	115	60	61	62	63	64	65	65
	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	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	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	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	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	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	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

Blood Pressure Levels for Girls by Age and Height Percentile

Age (Year)	BP Percentile	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	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	50th	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	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	50th	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	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	50th	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	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	50th	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	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	50th	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	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	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	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	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	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	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	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	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	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

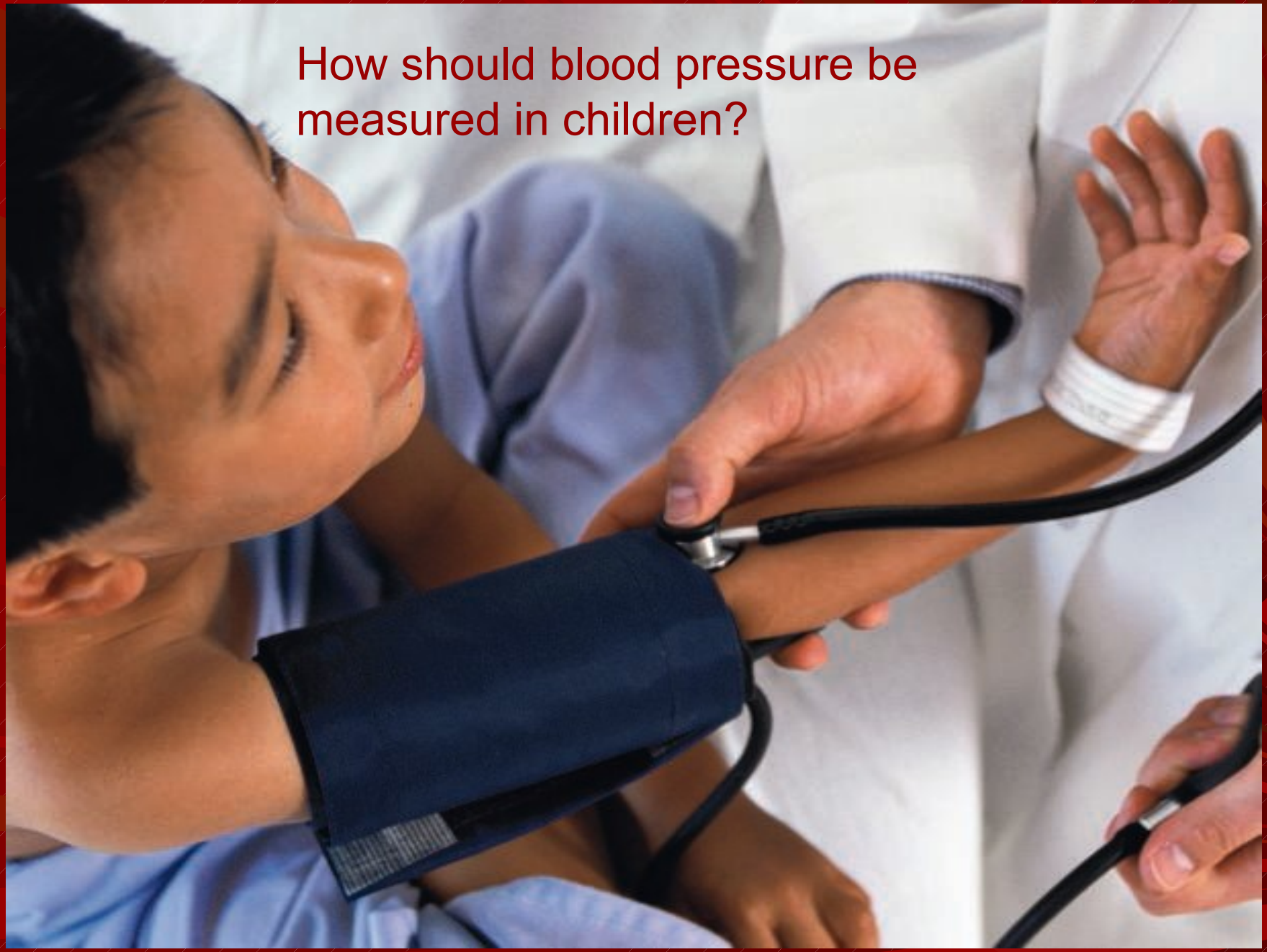
Blood Pressure Levels for Girls by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg) ← Percentile of Height →							Diastolic BP (mmHg) ← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	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	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	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	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	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	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	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	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	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	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	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	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	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

How should blood pressure be measured in children?

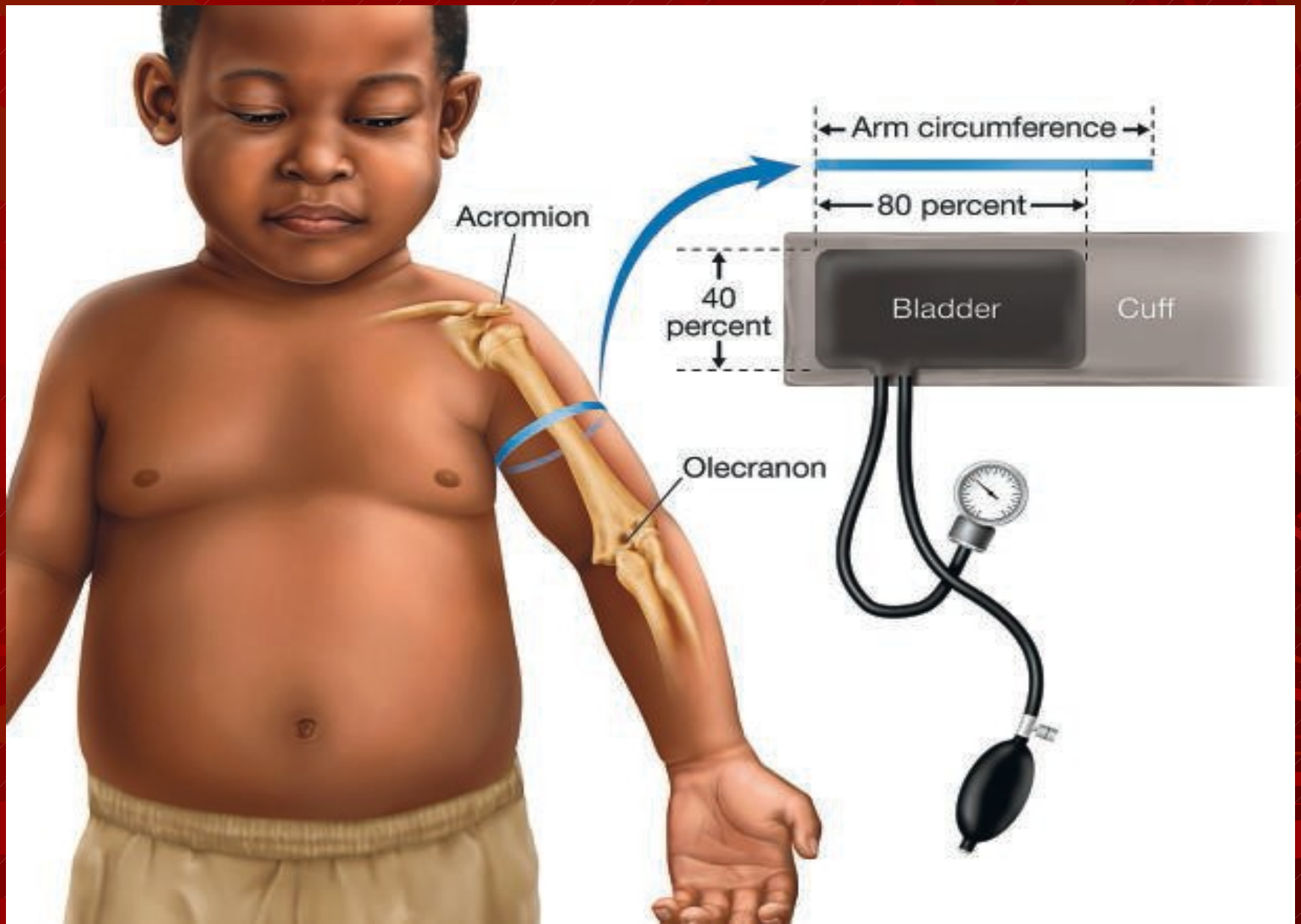
- The child should be calm and free of anxiety
- The child should have been sitting quietly for 5 minutes. The child should be sitting with back supported, both feet on the floor and right cubital fossa supported at heart level.

How should blood pressure be measured in children?



- Choose the appropriate cuff size:
- The cuff width should cover ~70% of the distance between the acromion and the olecranon .
- The cuff bladder length should be 80 to 100% of the arm circumference, and the cuff bladder width should be at least 40% of the arm circumference at the midpoint of the acromion-olecranon distance.

Choose the appropriate size cuff



Recommended Dimensions for Blood Pressure Cuff Bladders

Age Range	Width (cm)	Length (cm)	Maximum Arm Circumference (cm)*
Newborn	4	8	10
Infant	6	12	15
Child	9	18	22
Small adult	10	24	26
Adult	13	30	34
Large adult	16	38	44
Thigh	20	42	52

*Calculated so that the largest arm would still allow the bladder to encircle the arm by at least 80 percent.

METHODS

Palpatory Method	BP recording is 10 mm Hg less than that obtained by auscultatory method .
Auscultatory Method	Preferred method. BP tables are based on it.
Doppler Study	Non invasive procedure
Oscillometric Method	Better to record mean BP. Useful in infants and young children. BP > 90th percentile should be rechecked by auscultatory method.
Flush Method	Used in newborns. Only SBP can be recorded.
Ambulatory Blood Pressure Monitoring	White-coat hypertension Target-organ injury risk

POINTS TO BE REMEMBERED

- BP should be recorded in all 4 limbs.
- Cuff should not be applied two tight (low BP recording) or too loose (high BP recording).
- BP monitoring subsequently should be taken in the same limb and position.
- Normally the BP is 10-20mm Hg higher in lower limbs compared to the upper limbs.

ETIOLOGY

COMMONEST CAUSES

Newborn	Umbilical artery catheterization and Renal artery thrombosis.
Childhood	Renal disease, COA, endocrine disorders or medications.
Adolescents.	Essential hypertension becomes increasingly common.

CAUSES OF HYPERTENSION IN PEDIATRIC POPULATION

Renal Causes	Renal Parenchymal diseases (78%)
	Renal vascular diseases (12%)
Cardiovascular	CoA(2%)
	Condition with large stroke volume (PDA, AV fistula)
Endocrine	Hyperthyroidism
	Excessive Catecholamine levels (Pheochromocytoma)
	Adrenal dysfunction (CAH 11β, 17 α hydroxylase deficiency)
	Hyperaldosteronism (Conn's Syndrome, Renin Producing Tumors)
	Hyperparathyroidism
Neurogenic	Raised ICT, Poliomyelitis, LGB.
Drugs and Chemical	Sympathomimetic drugs , Amphetamines, Steroids, OCP, Heavy matal poising (Hg, Lead), Cocaine, Cyclosporine
Miscellaneous	Hypercalcemia, After Coarctation repair, Pre eclampsia etc.

Obesity-- for each one unit increase in BMI z-score, children 8 to 17 years of age have been shown to have twice the risk of having a BP greater than the 95th percentile.1

CLINICAL MANIFESTATION OF HYPERTENSION

- Many children with mild hypertension are asymptomatic and hypertension is diagnosed as a result of routine BP measurement.
- Severe hypertension may be symptomatic like headache, dizziness, nausea, vomiting, irritability, personality changes.
- Occasionally with complications like neurological, CHF, Renal dysfunction, Stroke.

APPROACH TO A PATIENT

HISTORY

- Present and Post History
  - Neonatal - prematurity, BPD, umbilical artery catheterization .
  - Cardiovascular- History of CoA or surgery for it, history of palpitation , Headache, excessive sweating (excessive catecholamine levels).
  - Renal- History of obstructive uropathy, UTI, radiation, trauma or surgery to kidney area.
  - Endocrine- weakness, fiushing, weight loss, muscle cramps (hyperaldosteronism). Constipation
  - Medication/Drugs - Corticosteroids, amphetamines, cold medications, antiasthamatic drugs, OCP, cyclosporine/tacrolimus, cocaine.NSAIDs Stimulant medications (eg, dexedrine, methylphenidate) Beta-adrenergic agonists (eg, theophylline) ,Erythropoietin, Tricyclic antidepressants, Recent abrupt discontinuation of antihypertensives
  -)

- Habits - Smoking/drinking/
  illicit drugs (eg, tobacco,ethanol,amphetamines,cocaine,phencyclidine,
- Symptoms of obstructive sleep apnea (ie, difficulty falling asleep, multiple nighttime awakenings, snoring, daytime somnolence
- Diet (caffeine, salt intake)

Family History

- Essential hypertension , atherosclerotic heart disease, stroke.
- Familial or hereditary renal disease (PKD etc.)

PHYSICAL EXAMINATION

- Accurate measurement of BP in all limbs.
- Complete physical examination.
  - Delayed growth/short stature (renal disease)
  - Bounding peripheral pulses (PDA, AR)
  - Weak or absent femoral pulses or BP differential between arms and legs (CoA)
  - Abdominal bruits (Renal Vascular Disease)
  - Abdominal mass(Wilms tumor, neuroblastoma, pheochromocytoma)
  - Palpable kidneys (Polycystic kidney disease, hydronephrosis, multicystic dysplastic kidney, mass)

- Skin lesions (café au lait spots, neurofibromas, adenoma sebaceum, striae, hirsutism, butterfly rash, Acanthrosis nigricans palpable purpura)
- Tenderness over kidney (renal infection).
- Ambiguous genitalia (CAH).
- Moon facies, truncal obesity, buffalo hump
- Thyromegaly, Proptosis, hyperdynamic circulation (Hyperthyroidism
- Signs of meningeal irritation, CNS Infections.
- Widely spaced nipples, Webbed neck (turner's)

ROUTINE LABORATORY TESTS

- Initial laboratory tests should be directed toward detecting renal parenchymal disease, renovascular disease, and COA and therefore should include urinalysis; urine culture; serum electrolyte, blood urea nitrogen, creatinine, and uric acid levels; ECG; chest X-ray studies; and possibly echo.

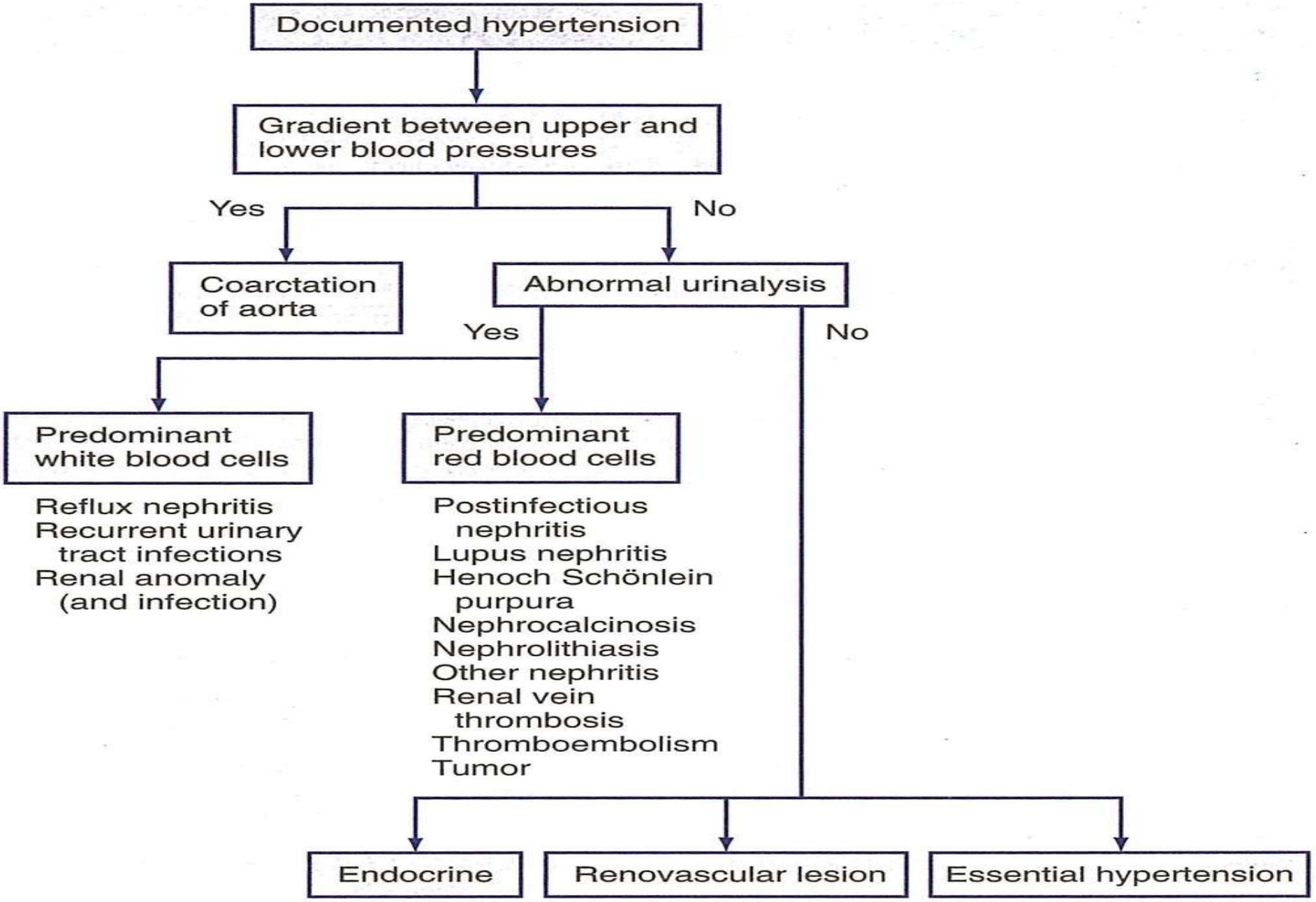
SPECIALIZED STUDIES

- More specialized studies may be indicated for the detection of rare causes of secondary hypertension.
- The decision to undertake special tests and procedures depends on the availability of and familiarity with the procedure, severity of hypertension, age of the patient and history and physical findings suggestive of a certain cause.

Routine and Special Laboratory Tests and Their Significance

Laboratory Test	Significance
Urinalysis, urine culture, blood urea nitrogen, creatinine, uric acid	Renal parenchymal disease
Serum electrolytes (hypokalemia)	Hyperaldosteronism (primary or secondary) Adrenogenital syndrome Renin-producing tumors
ECG, chest x-ray studies	Cardiac cause of hypertension; also baseline function
Intravenous pyelogram (or ultrasonography, radionuclide studies, computed tomography, or magnetic resonance imaging of the kidneys)	Renal parenchymal disease Renovascular hypertension Tumors (neuroblastoma, Wilms' tumor)
Plasma renin activity (peripheral)	High-renin hypertension (renovascular hypertension, renin-producing tumors, some Cushing's syndrome, some essential hypertension) Low-renin hypertension (adrenogenital syndrome, primary hyperaldosteronism)
24-hr urine collection for 17-ketosteroid and 17-hydroxycorticosteroids	Cushing's syndrome Adrenogenital syndrome
24-hr urine collection for catecholamine levels and vanillylmandelic acid	Pheochromocytoma Neuroblastoma
Aldosterone	Hyperaldosteronism (primary or secondary) Renovascular hypertension Renin-producing tumors
Renal vein plasma renin activity	Unilateral renal parenchymal disease Renovascular hypertension
Abdominal aortogram	Renovascular hypertension Abdominal coarctation of the aorta Unilateral renal parenchymal disease Pheochromocytoma
Intra-arterial digital subtraction angiography	Renovascular hypertension

Initial Diagnostic Algorithm in the Evaluation of Hypertension



Classification of Hypertension in Children and Adolescents: Therapy Recommendations

All patients to receive Therapeutic Life-style Changes (TLC)

	Pharmacologic Therapy
Normal	None
Prehypertension	Do not initiate therapy unless there are compelling indications such as chronic kidney disease (CKD), diabetes mellitus, heart failure, left ventricular hypertrophy (LVH).
Stage 1 hypertension	Initiate therapy based on indications for antihypertensive drug therapy or if there are compelling indications as above.
Stage 2 hypertension	Initiate therapy.

MANAGEMENT

Prehypertension or

asymptomatic, Stage 1 Primary HTN

(who do not have evidence of end-organ damage or diabetes)

Lifestyle modifications

(Non-pharmacologic interventions)

re-evaluated in six months

Not controlled

Antihypertensive

Non pharmacologic interventions-

- Weight reduction.
- Low salt intake*.
- Regular aerobic exercise.
- Dietary Approaches- fresh vegetables, fruits, and low-fat dairy
- Avoidance of smoking.

*Can start with recommending “no added salt” with ultimate goal of achieving the current recommendation of 1.2 grams/day total for 4- to 8-year-olds and 1.5 grams/day for children 9 years and older

CLASSIFICATION OF DRUGS

ACE inhibitors	Captropil, Enalapril
Angiotensin AT 1, antagonists	Losartan
Calcium channel blockers	Nifedipine, Verapamil.
Diuretics	Hydrochlorthizide, Furosemide, Spironolactone
β adrenergic blockers	Propranolol
α+β adrenergic blockers	Labetalol
α adrenergic blockers	Prazosin
Central sympatholytics	Clonidine
Vasodilators	Arterial (Hydralazine, Minoxidil), Mixed (Sodium nitropruside)

Indications for antihypertensive drug therapy

- Symptomatic hypertension
- Secondary hypertension
- Hypertensive target organ damage
- Diabetes(types 1 & 2)
- Persistent hypertension despite nonpharmacologic measures

Target-organ abnormalities are detectable in hypertensive children and adolescents.

- LVH reported (51 g/m$^{2.7}$) in 34-38% of children with mild, untreated HTN with high correlation to BP and in particular ABPM
- Working Group Recommendations:
  - Echocardiographic assessment of LV mass should be performed at diagnosis of HTN and periodically thereafter.
  - The presence of LVH is an indication to initiate or intensify antihypertensive therapy

Goals of antihypertensive therapy

- Reduction of BP to < 95th percentile without any concurrent conditions .

- Reduction of BP to <90th percentile with concurrent conditions (eg.Hyperlipidemia ,End organ damage, Obesity, CKD Complications etc)

How should I treat?

- **Step-1** - Starting with a single antihypertensive in small dose and proceeding to full dose .
- **Step-2** - If it produce no clinical improvement, a second antihyprtensive drug should be added or substituted.
- initial antihypertensive therapy

  a Calcium channel blocker (CCB) or an Angiotensin converting enzyme (ACE) inhibitor, unless there is a compelling reason to use an agent from another class

Pharmacologic interventions for pediatric hypertension

Drug class	Examples	Major side effects	Comments
Diuretics	• Hydrochlorothiazide • Metalozone • Furosemide • Torasemide	• Hypokalemia, hypercholesterolemia, hyperglycemia Rare side effects: • Blood dyscrasias, photosensitivity, pancreatitis	• Would avoid in children active in sports because of risk of dehydration and/or electrolyte disturbances • Electrolytes should be monitored one week after initiation and periodically thereafter • Most useful as adjunctive therapy (particularly with calcium channel blocker, direct vasodilators)
Potassium-sparing diuretics	• Spironolactone • Amiloride	• Hyperkalemia • Gynecomastia	• Would avoid in children active in sports because of risk of dehydration and/or electrolyte disturbances • Electrolytes should be monitored one week after initiation and periodically thereafter
Beta-blockers	• Atenolol • Timolol • Pindolol • Bisoprolol Propranolol Available in pediatric labeling:* • Metoprolol	Serious side effects: • Bronchospasm, congestive heart failure, masking of insulin-induced hypoglycemia, depression Less serious: • Poor peripheral circulation, insomnia, fatigue, decreased exercise tolerance, hypertriglyceridemia	• Preferred for hypertensive children who suffer from migraine headaches • Non-cardioselective agents are contraindicated in asthma and in children with heart failure; avoid in diabetics • May decrease athletic performance • Maximum dose may be limited by heart rate
Calcium channel blockers (CCBs)	• Verapamil, diltiazem • Dihydropyridines (Felodipine, Isradipine, Nicardipine, Nifedipine) Available in pediatric labeling:* • Amlodipine	• Conduction defects, decreased contractility, gingival hyperplasia, flushing, headache, peripheral edema	• Generally well tolerated • Consider for children active in sports
Angiotensin-converting enzyme inhibitors†	• Captopril • Ramipril Available in pediatric labeling:* • Benazepril* • Enalapril* • Fosinopril • Lisinopril*	• Cough, rash, loss of taste, hyperkalemia Rare side effects: • Leukopenia, anemia, angioedema	• Contraindicated in pregnancy and in children with hyperkalemia and/or bilateral renal artery stenosis (can cause flash pulmonary edema)* • Preferred medication for hypertensive diabetics or hypertensive patients with microalbuminuria or proteinuria • Should consider for obese children with primary hypertension • Need to monitor for hyperkalemia and renal failure one week after starting, with each dose increase, and periodically (every six to 12 mos after that)
Angiotensin receptor blockers†	Available in pediatric labeling:* • Losartan* • Valsartan* • Irbesartan (label states was ineffective in children)	• Hyperkalemia, cough (less frequent than with ACE inhibitors), angioedema	• Contraindicated in pregnancy* • Preferred medication for hypertensive diabetics or hypertensive patients with microalbuminuria, proteinuria • Need to monitor for hyperkalemia and renal failure one week after starting, with each dose increase and periodically (every six to 12 mos after that)
Alpha- and beta-blockers	• Labetalol • Carvedilol	• Postural hypotension, Beta-blocking side effects	• Preferred medication for hypertensive children who suffer from migraine headaches • Contraindicated in asthma and in children with heart failure; avoid in diabetics • May decrease athletic performance • Maximum dose may be limited by heart rate
Direct vasodilators	• Hydralazine • Minoxidil	• Headaches, tachycardia, lupus-like syndrome (hydralazine), fluid retention, hirsutism (minoxidil)	• Hydralazine: Long-term use not effective secondary to tolerance, edema • Minoxidil reserved for refractory cases in conjunction with other medications (particularly diuretics)
Central alpha antagonists	• Methyldopa • Clonidine	• Hepatic and “auto-immune” disorders (methyldopa), sedation, dry mouth, “withdrawal” (clonidine)	• Abrupt discontinuation can lead to severe rebound HTN

Monitoring and follow-up

- There are no specific, published guidelines regarding frequency of monitoring and follow-up after initiation of therapy, but in the beginning it would be reasonable to **measure a child's blood pressure at least weekly** and arrange for **follow-up every three months**.
- Once the child has achieved target BP's on a medication regimen, clinic follow-up can be spaced to **every six months.**

COMBINATION THERAPY

SYNERGISTIC COMBINATIONS.

Drugs increasing renin activity+ Drugs decreasing renin activity	ACE inhibitors , Diuretics + β blockers
Sympathic inhibitors and vasodilators cause fluid retention. Add diuretics	β blockers + Thiazide, Lasix
ACE inhibitors + Diuretics	Envas + Thiazide, Lasix
α Blocker + β blocker	Prazosin + Propranolol

COMBINATIONS TO BE AVOIDED

- α or β blocker + clonidine (antagonism)
- β blocker + CCB (marked bradycardia/ AV block).
- Any 2 drugs of same class.

SECONDARY HYPERTENSION

- Treatment should be aimed at removing the cause of hypertension whenever possible.
- Curable forms of Hypertension

Renal	Unilateral kidney disease (Nephritis, Pyelonephritis, hydronephrosis)
Cardiovascular	CoA, Renal artery stenosis, thrombosis.
Adrenal	Pheochromocytoma, Neuroblastoma, hyperaldosteronism
Miscellaneous	Drugs/ OCP etc.

Hypertensive crisis

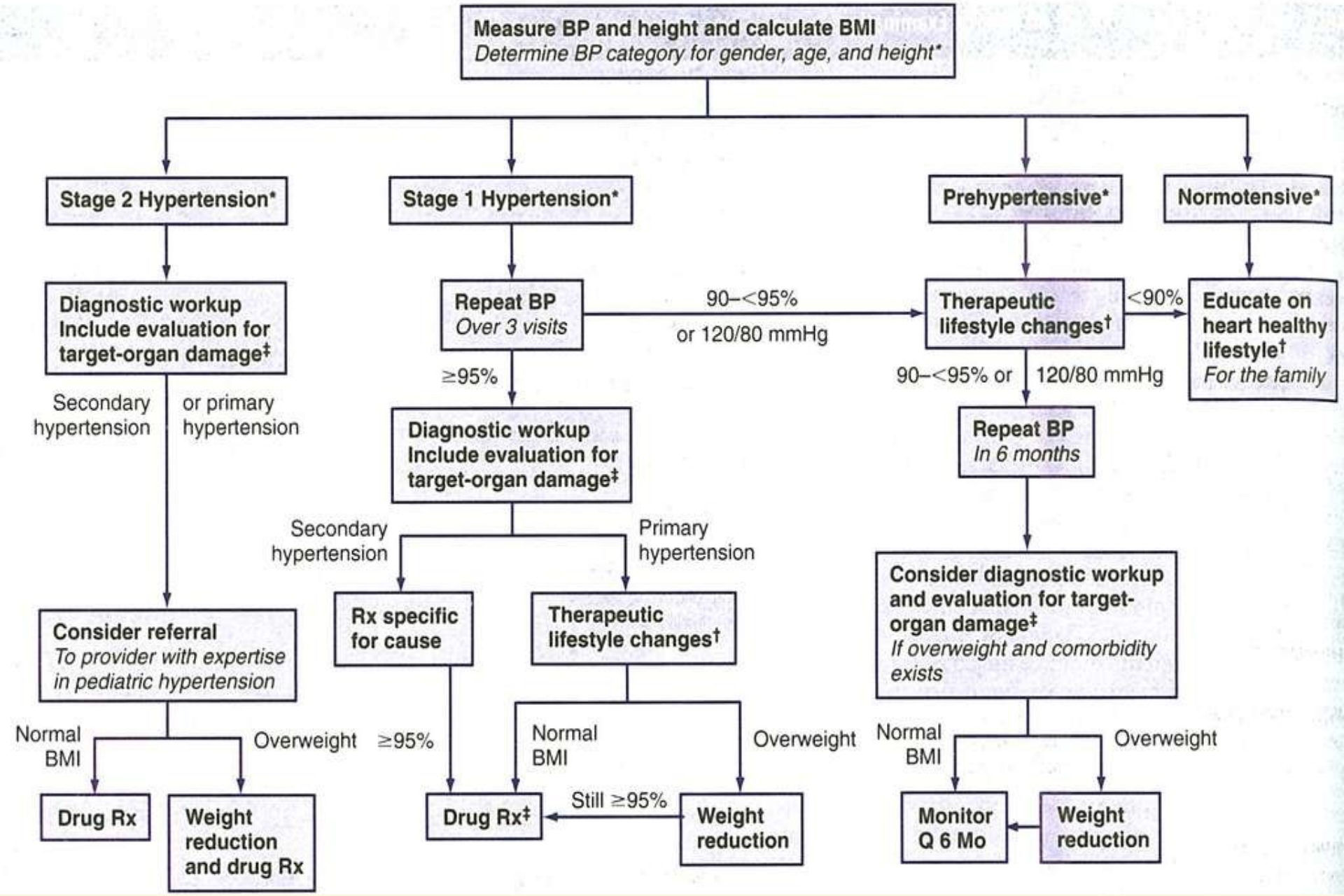
- Severe symptomatic hypertension with BP well above 99th percentile .
- Hypertensive emergencies(encepalopathy,chf)

controlled reduction in BP

25% in first 8hrs

then gradually normalising BP over 26-48 hrs.

- Hypertensive urgencies



Management Algorithm of Systemic Hypertension

CONCLUSIONS

- Hypertension is a silent killer. All children >3 years of age attending OPDs should have their BP recorded (Special circumstances in children < 3 years).
- Thorough history and physical examination followed by relevant investigations can clinch the cause of hypertension.
- Hypertension is a curable disease.

Thanks