

Hypertension

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Epidemiology

- Primary (essential) hypertension occurs commonly in adults and, if untreated, is a major risk factor for myocardial infarction, stroke, and renal failure.
- In adults with hypertension, a 5 mm Hg increase in diastolic blood pressure (BP) increased the risk of coronary artery disease by 20% and the risk of stroke by 35%.
- Furthermore, hypertension is implicated in the etiology of nearly 50% of adults with end-stage renal disease.
- The prevalence of adult hypertension increases with age, ranging from 15% in Young adults to 60% in individuals older than 65 yr.

DEFINITION OF HYPERTENSION

- The definition of hypertension in adults is BP $\geq 140/90$ mm Hg, regardless of body size, sex, or age.
- In children : systolic and diastolic values for the 50th, 90th, 95th, and 99th percentile by age, sex, and height percentile.

- Children with BP between the 95th and 99th percentile **plus 5 mm** Hg are categorized as stage 1 hypertension
- Children with BP above the 99th percentile **plus 5 mm Hg** have stage 2 hypertension.
- Stage 1 hypertension, if asymptomatic and without target organ damage, allows time for evaluation before starting treatment;
- Stage 2 hypertension calls for more prompt evaluation and pharmacologic therapy

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Definition

- Normal BP — Both systolic and diastolic BP <90th percentile.
- Prehypertension — Systolic and/or diastolic BP \geq 90th percentile but <95th percentile or if BP exceeds 120/80 mmHg (even if <90th percentile for age, gender, and height).
- Hypertension — HTN is defined as either systolic and/or diastolic BP \geq 95th percentile measured upon three or more separate occasions. The degree of HTN is further delineated by the two following stages.
- Stage 1 HTN — Systolic and/or diastolic BP between the 95th percentile and 5 mmHg above the 99th percentile.
- Stage 2 HTN — Systolic and/or diastolic BP \geq 99th percentile plus 5 mmHg.

MEASUREMENT OF BP IN CHILDREN

*The Fourth Report recommended that **children 3 yr or older** should have their BP checked during every health care episode.*

Selected children **<3 yr** old should also have their BP checked, including those with a history of **prematurity, congenital heart disease, renal disease, solid organ transplant, cancer, treatment with drugs known to raise BP, other illnesses associated with hypertension, or evidence of increased intracranial pressure.**

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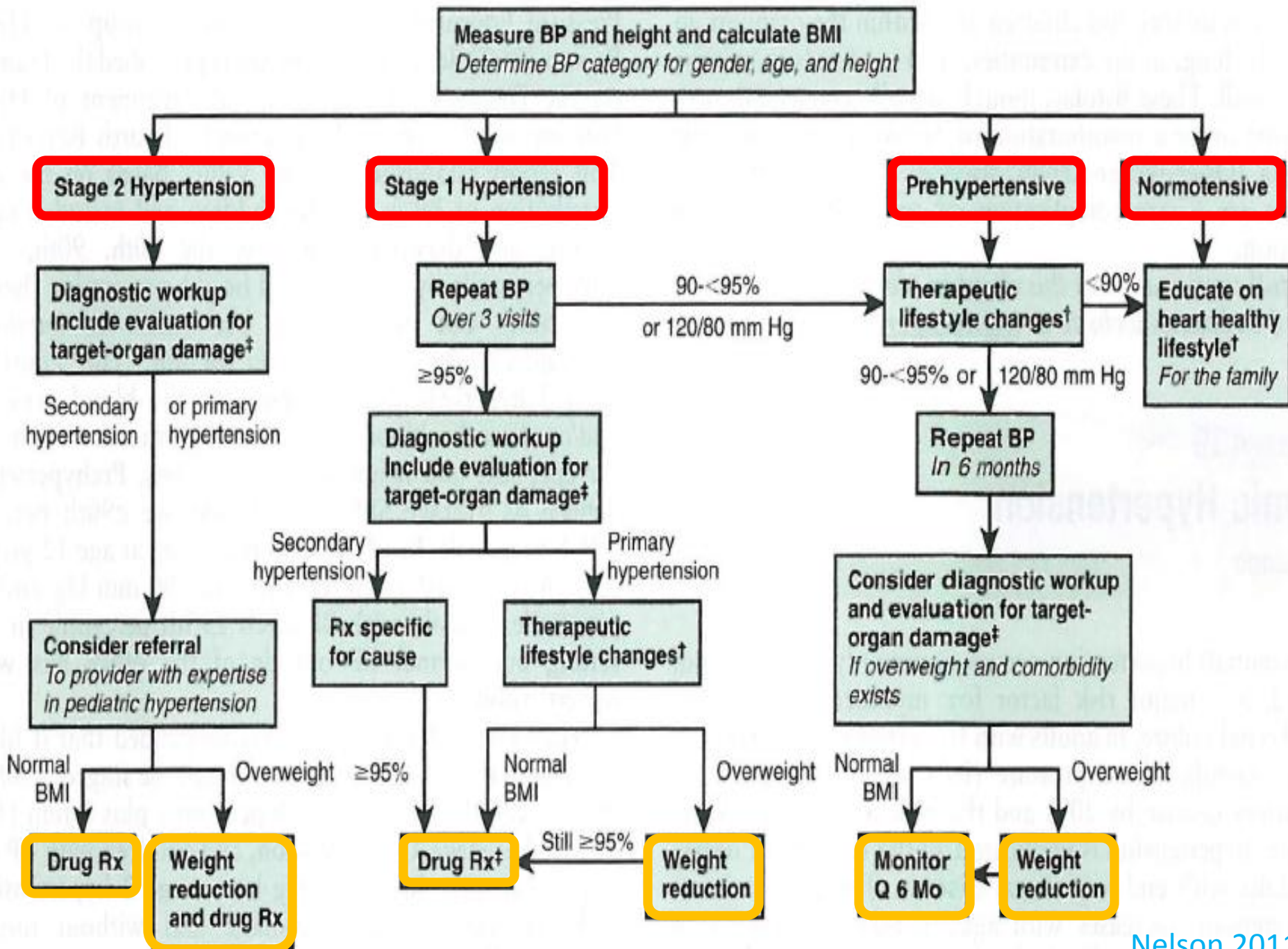
- Systolic pressure is indicated by appearance of **the 1st Korotkoff** sound.
- Diastolic pressure has been defined by consensus as the 5th Korotkoff sound.
- Palpation is useful for rapid assessment of SBP, although the **palpated pressure is generally about 10 mm Hg less** than that obtained via auscultation.
- Oscillometric techniques are used frequently in infants and young children, but they are susceptible to artifacts and are best for measuring **mean BP**.
- **Nelson 2011**

Most common cause of HTN by

Newborn	Infant – 6 years	6-10 years	> 10 years
Renal artery thrombosis or embolus	Renal parenchymal dis.	Renal parenchymal dis.	Essential HTN
RVT	RAS	RAS	White coat HTN
Congenital renal malformation	Coarctation of aorta	Essential HTN	Renal parenchymal dis.
Coarctation of aorta	Medication: Corticosteroid Pseudoephedrin Albuterol	Endocrine Dis.	Substance abuse
Renal artery stenosis (RAS)			Endocrine Dis.
BPD			

Causes of secondary hypertension in children and adolescents

Renal disease	Endocrine disease	Pharmacologic causes	Vascular disease	Neurologic /Psychologic causes
Pyelonephritis	Hyperthyroidism	Sympathomimetics	Renal artery abnormalities	Increased intracranial pressure
Renal parenchymal disease	Congenital adrenal hyperplasia	Corticosteroids	Renal vein thrombosis	Guillain-Barré syndrome
Congenital anomalies	Cushing syndrome	Stimulants	Coarctation	
Reflux nephropathy	Primary aldosteronism	Oral contraceptives	PDA	Mental stress
Acute glomerulonephritis	Primary hyperparathyroidism	Anabolic steroids	Arteriovenous fistula	Anxiety
Henoch-Schönlein purpura	Diabetes mellitus	Cocaine	Other causes	
Renal trauma	Hypercalcemia	Phencyclidine (PCP)	Neuroblastoma	
Hydronephrosis	Pheochromocytoma	Licorice	Heavy metal poisoning	
Hemolytic uremic syndrome		Nicotine	Acute pain	
Renal stones		Caffeine	Collagen vascular diseases	
Nephrotic syndrome			Neurofibromatosis	
Wilm's tumor			Tuberous sclerosis	
Hypoplastic kidney				
Polycystic kidney disease	Curr Opin Pediatr 2003; 15:370.			



- **Neonate:**

Hypertension in the premature infant is most often associated with umbilical artery catheterization and renal artery thrombosis.

- **Childhood:**

Hypertension during early childhood may be due to renal disease, coarctation of the aorta, endocrine disorders, or medications.

- **Older school-aged:**

primary hypertension becomes increasingly common.

CLINICAL MANIFESTATIONS

- Usually asymptomatic
- Obesity
- Growth failure in children with chronic kidney disease.
- Headache
- Dizziness
- Epistaxis
- Anorexia
- Visual changes
- Seizures
- Hypertensive encephalopathy
- Cardiac failure
- Pulmonary edema
- Renal dysfunction
- Bell palsy (the etiology is unknown.)

Hypertensive encephalopathy

- Hypertensive encephalopathy (generalized or posterior reversible encephalopathy syndrome [PRES]) is suggested by the presence of vomiting, temperature elevation, ataxia, stupor, CT abnormalities, and seizures.

Hypertensive crisis

Hypertensive crisis may manifest with:

- Decreased vision (retinal hemorrhages of
- hypertensive retinopathy)
- Papilledema
- Encephalopathy (headache, seizures, depressed level of consciousness)
- Heart failure
- Accelerated deterioration of renal function.

Target-organ injury

Subclinical hypertensive target-organ injury is a common clinical manifestation in children with essential hypertension. With the use of echocardiography utilizing pediatric normative data, **left ventricular hypertrophy** is detected in up to **40%** of hypertensive children.

Other markers of target organ damage that have been demonstrated in hypertensive children include :

- **Increased carotid intima-media thickness**
- **Hypertensive retinopathy**
- **Microalbuminuria.**

HYPERTENSIVE RETINOPATHY

In the early stages of hypertension, no retinal changes may be observable.

Generalized constriction and irregular narrowing of the arterioles are usually the first signs in the fundus.

Other alterations include retinal edema, flame-shaped hemorrhages, cotton-wool spots (retinal nerve fiber layer infarcts), and papilledema.

These changes are reversible if the hypertension can be controlled in the early stages, but in long-standing hypertension, changes may be irreversible.

Thickening of the vessel wall can produce a silver- or copper-wire appearance.

Hypertensive retinal changes in a child should alert the physician to renal disease, pheochromocytoma, collagen disease, and cardiovascular disorders, particularly coarctation of the aorta.

HYPERTENSIVE ENCEPHALOPATHY (PRES)

- Posterior reversible leukoencephalopathy syndrome (PRES) is seen in children with hypertension, often in the context of an acute rise in blood pressure.
- Posterior regions are selectively involved, typically resulting in symptoms of bilateral cortical visual dysfunction in addition to encephalopathy and seizures.

Hypertensive encephalopathy

- Hypertensive encephalopathy is most commonly associated with renal disease in children, including acute glomerulonephritis, chronic pyelonephritis, and end-stage renal disease
- In some cases, hypertensive encephalopathy is the initial manifestation of underlying renal disease.
- Marked systemic hypertension produces vasoconstriction of the cerebral vessels, which leads to vascular permeability, causing areas of focal cerebral edema and hemorrhage.
- The onset may be acute, with **seizures and coma**, or more indolent, with **headache, drowsiness and lethargy, nausea and vomiting, blurred vision, transient cortical blindness, and hemiparesis**.
- Examination of the eyegrounds may be non diagnostic in children, but **papilledema and retinal hemorrhages** may occur.
- MRI often shows increased signal intensity in the occipital lobes on T2 weighted images, which is known as posterior reversible leukoencephalopathy (PRES) and may be confused with cerebral infarctions. These high signal areas may appear in other regions of the brain as well.
- Treatment is directed at restoration of a normotensive state and control of seizures with appropriate anticonvulsants.

EVALUATION FOR IDENTIFIABLE CAUSES

History, including sleep history, family history, risk factors, diet, and habits such as smoking and drinking alcohol; physical examination

BUN, creatinine, electrolytes, urinalysis, and urine culture

CBC

Renal U/S

EVALUATION FOR CO-MORBIDITY

Fasting lipid panel, fasting glucose

Drug screen

Polysomnography

EVALUATION FOR TARGET-ORGAN DAMAGE

Echocardiogram

Retinal exam

ADDITIONAL EVALUATION AS INDICATED

ABPM

Plasma renin determination

Renovascular imaging
Isotopic scintigraphy (renal scan)
MRA
Duplex Doppler flow studies
3-Dimensional CT

Arteriography: DSA or classic

Plasma and urine steroid levels

Plasma and urine catecholamines

Evaluation of Hypertension

Mild-Mod.

Severe



Hx, P Ex.
CBC, U/A
Serum electrolytes, uric acid
VBG, BUN, Creat.
Renal US ± Doppler

Abnormal

Normal evaluation
Obesity,
Positive Family Hx.

Renovascular Diseases

Captopril scan
DSR, MRA
Renin level

R/O Essential HTN
Lipid profile
Echocardiography
ABPM

Renal parenchymal dis.

C3, C4, ANA,
Anti DNA, ANCA
Anti GBM, Renal Bx.

R/O RVH
Captopril scan, DSR, MRA
Renal vein or p renin

Renal Congenital anomalies

DMSA, VCUG
Urine culture

Endocrine diseases

Plasma metanephrine
MIBG scan
TFT, P Cortisol, ACTH
U 17 OH corticosteroid
P & U Aldosterone
Ca, P, PTH, Vit D

Endocrine profile

Plasma renin activity

Plasma renin concentration

Plasma aldosterone concentration-to-
-plasma renin activity (PAC/PRA) ratio

P & U Aldosterone

Abdominal CT / MRI

P Cortisol, ACTH, U 17 OH corticosteroid

TFT

Ca, P, PTH, Vit D

U VMA, Plasma metanephrine

MIBG scan

Treatment

- lifestyle modification with dietary changes and regular exercise. Weight loss is the primary therapy in obesity-related hypertension.
- diet increased in fresh fruits, fresh vegetables, fiber, and nonfat dairy and reduced in sodium.
- In addition, regular aerobic physical activity for at least 30-60 min on most days along with a reduction of sedentary activities to less than 2 hr per day is recommended.

Pharmacologic therapy

- Indications for pharmacologic therapy include symptomatic hypertension, secondary hypertension, hypertensive target organ damage, diabetes (types 1 and 2), and persistent hypertension despite non pharmacologic measures

Acceptable drug classes for use in children include :

- ACE inhibitors
- Angiotensin receptor blockers
- Beta-blockers
- Calcium channel blockers
- Diuretics

- The goal of therapy for hypertension should be to reduce BP
- below the 95th percentile, except in the presence of chronic
- kidney disease, diabetes, or target organ damage, when the goal
- should be to reduce BP to less than the 90th percentile.

Prevention

- Prevention of cardiovascular disease and stroke,
- Obesity
- elevated serum cholesterol levels
- high dietary sodium intake
- a sedentary lifestyle
- alcohol and tobacco use.
- increase in physical activity through school and community-based programs.