



Children with Hypertension in ED

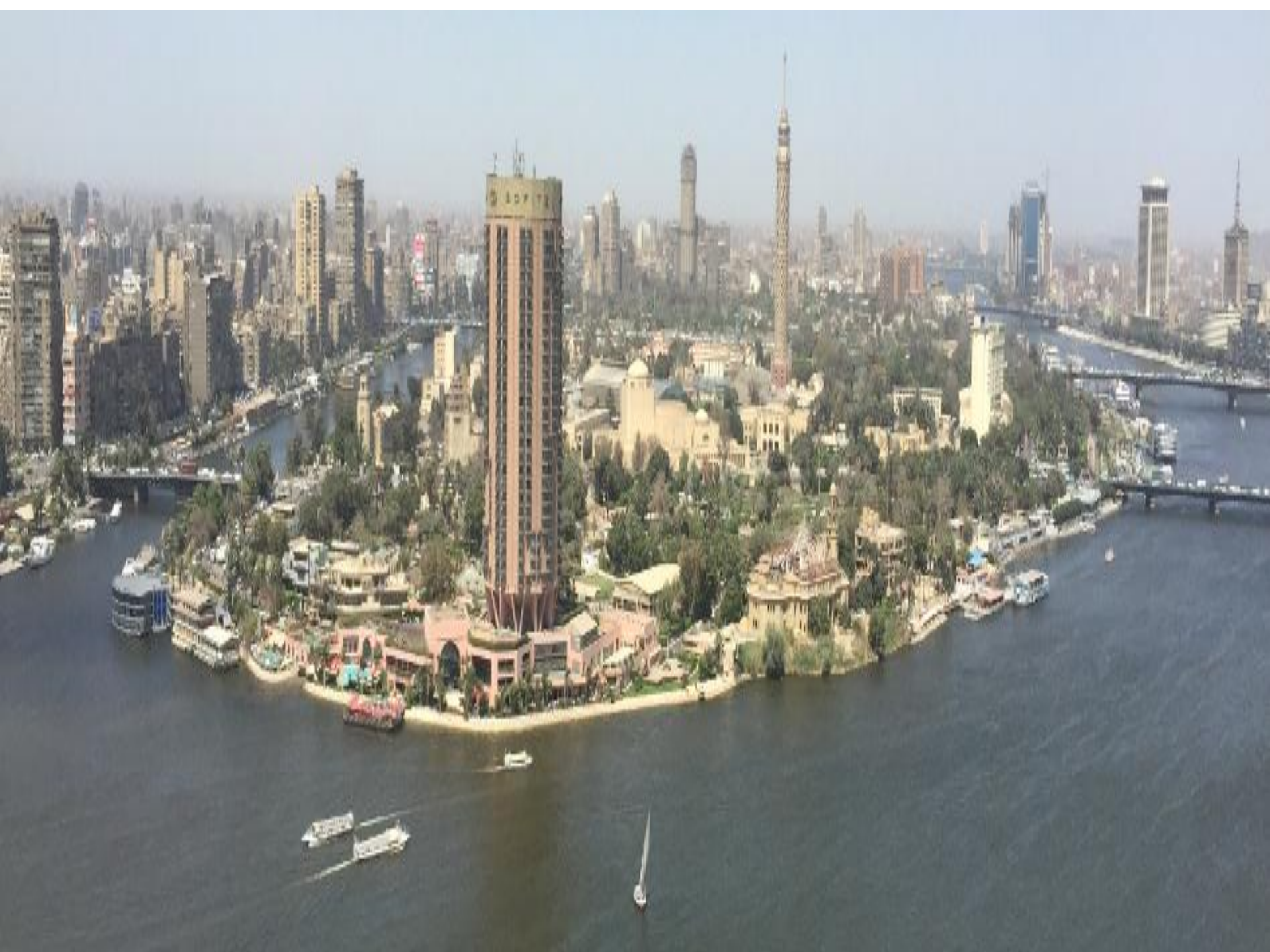
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Learning Outcomes

- Definition and Classification of hypertension in children
- Standard BP Nomograms & Physiological BP charts
- Epidemiology
- Measurement of BP
- Common Signs and Symptoms
- Causes of Hypertension
- Hypertensive Crisis
- End organ damage
- Hypertensive Encephalopathy
- Management of Hypertensive Emergency in Children

Definition of Hypertension in Children

According to national consensus statement guideline

Hypertension in Children is defined as:

A child with **3 or more** either systolic and/or diastolic BP measurements above the **≥95th percentile** for age, gender, and height should be considered hypertensive.

A clear understanding is required of when elevated BP requires **emergent**, **urgent**, or **routine** care.

BP Classification/ Interpretation

BP is classified by SBP and/or DBP percentiles for age/sex/height.

- If SBP or DBP **>90th** percentile, **repeat twice** at same office visit before interpreting result.
- **Stage 1 hypertension:** SBP and/or DBP between the **95th** percentile and **5 mmHg above the 99th** percentile.
- **Stage 2 hypertension:** SBP and/or DBP more than **5 mmHg above the 99th** percentile.

Transient Hypertension

Means transient BP elevation caused by any emotional, painful, or uncomfortable events.

- Defined as an **asymptomatic** BP higher than the **95th** percentile **only once or twice**, but returning to less than the 95th percentile on the second or third measurement **without any antihypertensive medication**.

Standard BP Nomograms for Boys by Age and Height

Blood Pressure Levels for Girls by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systemic BP (mmHg)							Pulmonary BP (mmHg)						
		↕ Percentile of Height ↕							↕ Percentile of Height ↕						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	85	84	83	82	81	80	79	52	51	50	49	48	47	46
	90th	87	87	86	85	84	83	82	53	53	52	51	50	49	48
	95th	88	88	87	86	85	84	83	54	54	53	52	51	50	49
	99th	89	89	88	87	86	85	84	55	55	54	53	52	51	50
2	50th	85	85	84	83	82	81	80	45	44	44	43	42	41	40
	90th	86	86	85	84	83	82	81	47	46	46	45	44	43	42
	95th	87	87	86	85	84	83	82	48	47	47	46	45	44	43
	99th	88	88	87	86	85	84	83	49	48	48	47	46	45	44
3	50th	86	87	86	85	84	83	82	47	46	46	45	44	43	42
	90th	88	88	87	86	85	84	83	49	48	48	47	46	45	44
	95th	89	89	88	87	86	85	84	50	49	49	48	47	46	45
	99th	90	90	89	88	87	86	85	51	50	50	49	48	47	46
4	50th	86	88	87	86	85	84	83	50	49	49	48	47	46	45
	90th	88	89	88	87	86	85	84	52	51	51	50	49	48	47
	95th	89	90	89	88	87	86	85	53	52	52	51	50	49	48
	99th	90	91	90	89	88	87	86	54	53	53	52	51	50	49
5	50th	86	89	88	87	86	85	84	50	49	49	48	47	46	45
	90th	88	90	89	88	87	86	85	52	51	51	50	49	48	47
	95th	89	91	90	89	88	87	86	53	52	52	51	50	49	48
	99th	90	92	91	90	89	88	87	54	53	53	52	51	50	49
6	50th	86	90	89	88	87	86	85	50	49	49	48	47	46	45
	90th	88	91	90	89	88	87	86	52	51	51	50	49	48	47
	95th	89	92	91	90	89	88	87	53	52	52	51	50	49	48
	99th	90	93	92	91	90	89	88	54	53	53	52	51	50	49
7	50th	86	91	90	89	88	87	86	50	49	49	48	47	46	45
	90th	88	92	91	90	89	88	87	52	51	51	50	49	48	47
	95th	89	93	92	91	90	89	88	53	52	52	51	50	49	48
	99th	90	94	93	92	91	90	89	54	53	53	52	51	50	49
8	50th	86	92	91	90	89	88	87	50	49	49	48	47	46	45
	90th	88	93	92	91	90	89	88	52	51	51	50	49	48	47
	95th	89	94	93	92	91	90	89	53	52	52	51	50	49	48
	99th	90	95	94	93	92	91	90	54	53	53	52	51	50	49
9	50th	86	93	92	91	90	89	88	50	49	49	48	47	46	45
	90th	88	94	93	92	91	90	89	52	51	51	50	49	48	47
	95th	89	95	94	93	92	91	90	53	52	52	51	50	49	48
	99th	90	96	95	94	93	92	91	54	53	53	52	51	50	49
10	50th	86	94	93	92	91	90	89	50	49	49	48	47	46	45
	90th	88	95	94	93	92	91	90	52	51	51	50	49	48	47
	95th	89	96	95	94	93	92	91	53	52	52	51	50	49	48
	99th	90	97	96	95	94	93	92	54	53	53	52	51	50	49

Standard BP Nomograms for Girls by Age and Height

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

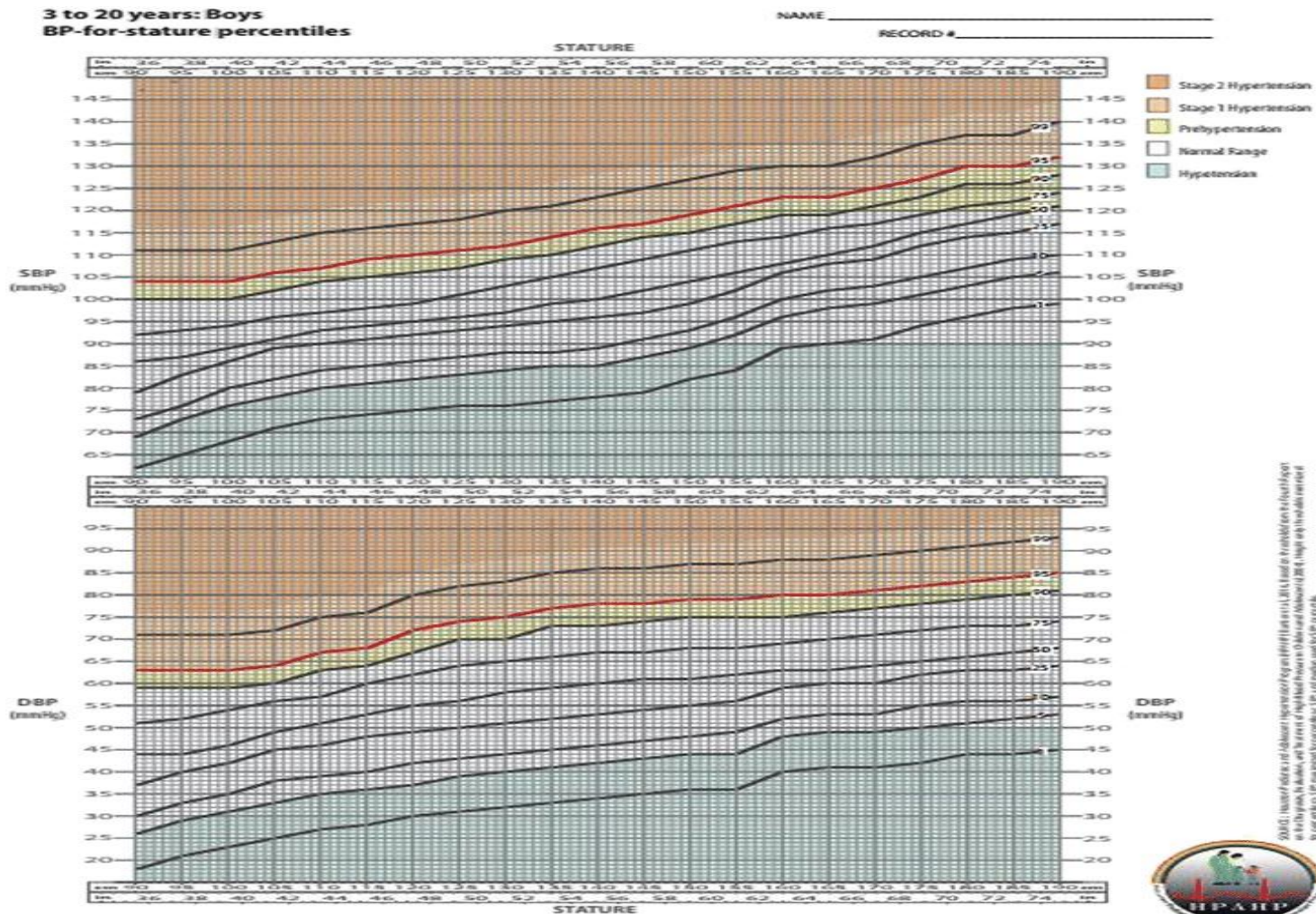
Age (years)	BP Percentile	Systolic BP (mmHg)								Diastolic BP (mmHg)							
		Percentile of height								Percentile of height							
		5th	10th	25th	50th	75th	90th	95th	99th	5th	10th	25th	50th	75th	90th	95th	99th
11	50th	100	101	102	103	104	106	107		60	60	60	61	62	63	63	
	90th	114	114	116	117	118	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	88	
12	50th	100	100	101	102	103	105	106		61	61	61	62	63	64	64	
	90th	118	118	117	119	120	121	122		75	75	75	76	77	78	78	
	95th	119	120	121	122	124	126	126		78	78	78	80	81	82	82	
	99th	127	127	128	129	131	132	133		86	86	87	88	88	89	89	
13	50th	104	105	106	107	108	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	108	110	111	112		63	63	63	64	65	66	66	
	90th	119	120	121	122	124	126	126		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	126	128	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	109	110	111	112	114	114		64	64	65	66	67	67	68	
	90th	121	122	123	124	126	127	128		78	78	78	80	81	81	82	
	95th	125	126	127	128	130	131	132		82	82	82	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	112	114	115		64	65	65	66	67	67	68	
	90th	122	122	123	125	126	127	128		78	78	78	80	81	81	82	
	95th	126	126	127	128	130	131	132		82	82	82	84	85	85	86	
	99th	133	133	134	136	137	138	139		90	90	91	91	92	93	93	

BP= blood pressure

* The 50th percentile is 1.28 SD, 90th percentile is 1.64 SD, and the 95th percentile is 2.32 SD over the mean.

† For research purposes, the standard deviations in Appendix Table B-1 show how to compute BP z-scores and percentiles for girls with height percentiles given in Table B-1 (i.e., the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height z-scores given by (5th = -1.645, 10th = -1.28, 25th = -0.675, 50th = 0, 75th = 0.675, 90th = 1.28, 95th = 1.645). (50th = 0.00) and then converted according to the relationship in steps 2-4 described in Appendix B. For children with height percentiles other than those listed, follow steps 1-4 as described in Appendix B.

Physiological BP charts with both systolic and diastolic percentiles (For Boys 3-20 years old)



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Epidemiology

- **Hypertension, defined as** either SBP and/or DBP $\geq 95^{\text{th}}$ percentile (for age, gender, and height) measured upon 3 or more occasions: is present in **2 - 5%** of the pediatric population and is **frequently undiagnosed**.
- **Hypertensive emergencies** in children occur in **<1%** of ED visits.
- **Increasing pediatric hypertension** is due to high salt intake, childhood obesity, decrease physical activity, and hyperlipidemia.

Measurement of BP

- Begin routine BP measurement at **3 years of age**.
- The correct **cuff size** depends on arm size (largest cuff that will fit on the upper arm with room below for the stethoscope head).
- BP should be measured in the **right arm** of a **relaxed, seated** child, with the **cubital fossa at heart level**.
- BP measurement by **auscultation** is the **Gold Standard**.
- BP by **automated (oscillometric)** device correlates reasonably well with auscultation, with advantages of rapid measurement remote from child and elimination of reader error.
- If BP is **high by automated** device, **repeat by auscultation**.

Common Signs and Symptoms

*Hypertension presents with **unspecific** signs and symptoms:*

- Headache (most common)
- Dizziness, Altered consciousness
- Falling asleep, daytime tiredness
- Nausea/vomiting
- Chest pain
- Abdominal pain
- Renal disorders
- Also, oral contraceptives, steroids, and illicit drugs (e.g., cocaine, amphetamines) should be asked about in >10 years old children

Hazards of Hypertension in Children

High BP contributes to:

- Early development of cardiovascular **structural** and **functional** changes.

With increasingly high BP:

- **Autoregulation** eventually **fails**, leading to damage of the vascular wall & further organ hypoperfusion.

Major Causes of Hypertension in Children

- **Essential** hypertension
- **Secondary** hypertension
 - **Renal** diseases (major underlying cause)
 - **Endocrine/metabolic** disorders.
 - **Catecholamine producing tumors**, such as pheochromocytoma and paraganglioneuroma
 - **Sympathetic stimulation** by tumors, renin-angiotensin system or drugs.
 - **Volume overload**

Hypertensive Crisis in Children

By Definition:

A **critical** condition characterized by a **rapid**, **inappropriate** and **symptomatic elevated BP**

Is a **relatively rare** condition presenting with:

- Elevated BP (**rapid**, **inappropriate**)
- Related symptoms are present
- It is potentially life-threatening (critical).

Categories of Hypertensive Crisis

Is categorized into 2 Severity Groups:

- **Hypertensive Urgency:** an elevation in SBP and/or DBP **> 5 mmHg above the 99th percentile without** damage of target-organs.
- **Hypertensive Emergency:** an elevation in SBP and/or DBP **> 5 mmHg above the 99th percentile** & is “**associated with**” acute or ongoing rapid deterioration of target-organs (heart, brain, kidneys and arteries), and is a potentially **life-threatening** condition, **requiring appropriate & immediate antihypertensive** medications to prevent further damage.

End organ damage

- Defined as **impairment** in renal, myocardial, hepatic, and hematologic functions, and neurological manifestations derived from HTN.
- **Acute (transient)** end organ damage is identified by abnormal clinical and laboratory findings which **subsides after a decrease in BP**.
- **Abnormal data includes:**
 - abnormal ECG
 - impaired renal function tests
 - elevated liver function markers
 - neurological manifestations such as headache, altered consciousness and dizziness.

Hypertensive Encephalopathy

Is an **acute neurological change** in the setting of **sudden and/or prolonged HTN** that overcomes the autoregulatory capacity of the cerebral vasculature.

- Severe Hypertension
- A combination of various neurological manifestations as:
 - headache
 - altered mental status
 - nausea, vomiting
 - visual disturbance
 - seizure, or even stroke
 - commonly presents with reversible posterior leukoencephalopathy seen on T2-weighted brain MRI



A decorative graphic consisting of a teal circle on the left and a teal closing bracket on the right, both partially overlapping a horizontal grey bar.

Management of Hypertensive Emergency in Children

Guidelines

Thorough evaluation of a child with a Hypertensive Emergency includes:

- Accurate BP readings.
- Complete and focused symptom history.
- Past medical, surgical, and family history.
- Physical exam: height, weight, four-limb BP.
- General overall examination and especially detailed cardiovascular and neurological examinations, including fundoscopic examination.
- Initial work-up: ECG, chest X-ray, serum chemistries, CBC, and urinalysis. Others as dictated by clinical features: renal ultrasonography, echocardiography, arteriography & brain CT-scan.

History Includes:

- Frequency of urinary tract infections (dysuria hematuria, frequency)
- Unexplained fevers
- Edema
- History of umbilical artery catheterization (neonate)
- History of head trauma
- Ingestion of illicit drugs, oral contraceptives
- Rapid withdrawal of anti-hypertension drugs
- History of flushing, sweating, fever, weight loss

Physical Examination

Should pay a particular attention to:

- Cardiovascular system; heart rate, heart sounds
- Neurological examination
- Renal system
- Four-limb BP
- Respiratory rate, lung sounds
- Oxygen saturation
- Funduscopic examination
- Auscultation abdomen

Implication for Health Care Practice

- **Hypertension crisis**: needs evaluation and initiation of treatment in the ED, and BP reduction must be performed **before the cause** of the hypertension is known.
- **Asymptomatic Mild to Moderate hypertension** without end organ damage: adequate follow-up must be certified & referral of the child for family physician.
- **Educational guides** about **Lifestyle modification** for obesity, low-salt diet, exercise and avoiding stress is effective for treatment of hypertension, particularly if it is begun from childhood.

General Guidelines

- **Normal BP:**
 - ⇒ Recheck in 1 year.
- **Prehypertension:**
 - ⇒ Recheck in 6 months.
 - ⇒ Begin weight management (as appropriate).
- **Stage 1 hypertension:**
 - ⇒ Recheck in 1 - 2 weeks. ⇒ If BP remains at this level on recheck, begin evaluation and treatment including weight management if appropriate.
- **Stage 2 hypertension:**
 - ⇒ Begin evaluation and treatment within 1 week, and immediately if symptomatic.

Hypertension Crisis Guidelines

- Cardiac monitoring.
- Placement of **Foley's catheter** is necessary.
- **Arterial catheter** is preferable for continuous BP readings.
- **BP must not be reduced more than 25% over 8 hours.**
- **Gradual reduction** of BP over the **next 24-48 hours.**
- **Aggressive reduction of BP:** Ischemic complications such as renal injury, acute neurologic issues, and blindness.
- **Must be treated with "IV" antihypertensives** (rapid onset, short half-life).
- **Oral medication should be avoided.**
- Medications should be **chosen according** to their side effect profile, availability, and physician familiarity.

Hypertensive Urgency & Mild to Moderate hypertension

- **Hypertensive urgency in the ED:** may be treated with oral antihypertensive agents.
- **Mild to moderate hypertension in the ED:** patients are discharged with instructions. ED physician must certify adequate follow-up for outpatient evaluation and treatment.

Antihypertensive drug agents used in treatment of “Hypertensive Crisis” in children 1 - 18 years old

Drug	Dosage	Route	Onset of action	Duration	Comment
Labetalol	Bolus: 0.2–1.0 mg/kg/dose, maximum : 40 mg/dose, infusion: 0.25–3.0 mg/kg/h	IV bolus or infusion	5-10 min	2-4 h	Contraindications: asthma , chronic lung disease, heart failure . May mask hypoglycemic symptoms.
Nicardipine	0.5–3.0 µg/kg/min	IV infusion	2-5 min	30-60 min	May cause increased intracranial pressure , headache, nausea, and hypotension.
Hydralazine	0.1–0.5 mg/kg/dose; maximum: 20 mg/dose	IV, IM	10-30 min	4-12 h	Administer every 4 h when given as IV bolus. Not as strong as other agents. Recommended dose is less than U.S. Food and Drug Administration–approved label.
Sodium nitroprusside	0.3–8.0 µg/kg/min	IV infusion	Seconds	During infusion only	Increase intracranial pressure . Monitor cyanide and thiocyanate levels for patients with renal and liver disease when administering for >24–48 h.
Esmolol	100–500 µg/kg/min (initial dose), then 50–300 µg/kg/min	IV	Seconds	10-20 min	May cause bronchospasm , congestive heart failure , and profound bradycardia.

Antihypertensive drug agents used in treatment of “Hypertensive Urgency” in Children 1 - 18 Years old

Drug	Dosage	Route	Comments
Nifedipine	0.1–0.25 mg/kg/dose	PO, sublingual	Precipitous drop in blood pressure, tachycardia, headache, Rebound hypertension
Minoxidil	0.1–2 mg/kg/dose	PO	Pericardial effusion
Isradipine	0.05–0.1 mg/kg/dose up to 5 mg/dose	PO	Tachycardia, headache
Clonidine	0.05–0.3 mg	PO	Rebound hypertension, sedation

Nifedipine in Hypertension Crisis

- Nephrologists prescribe short-acting nifedipine to treat moderate to severe hypertension.
- But there are reports of **adverse neurologic events** due to **rebound hypertension**.
- **Oral** nifedipine is **contraindicated** in patients with **hypertension crisis**. May cause complications such as **intracerebral bleeding**, because of the inability to control the amount of BP reduction.

Any Questions



THANK YOU

