



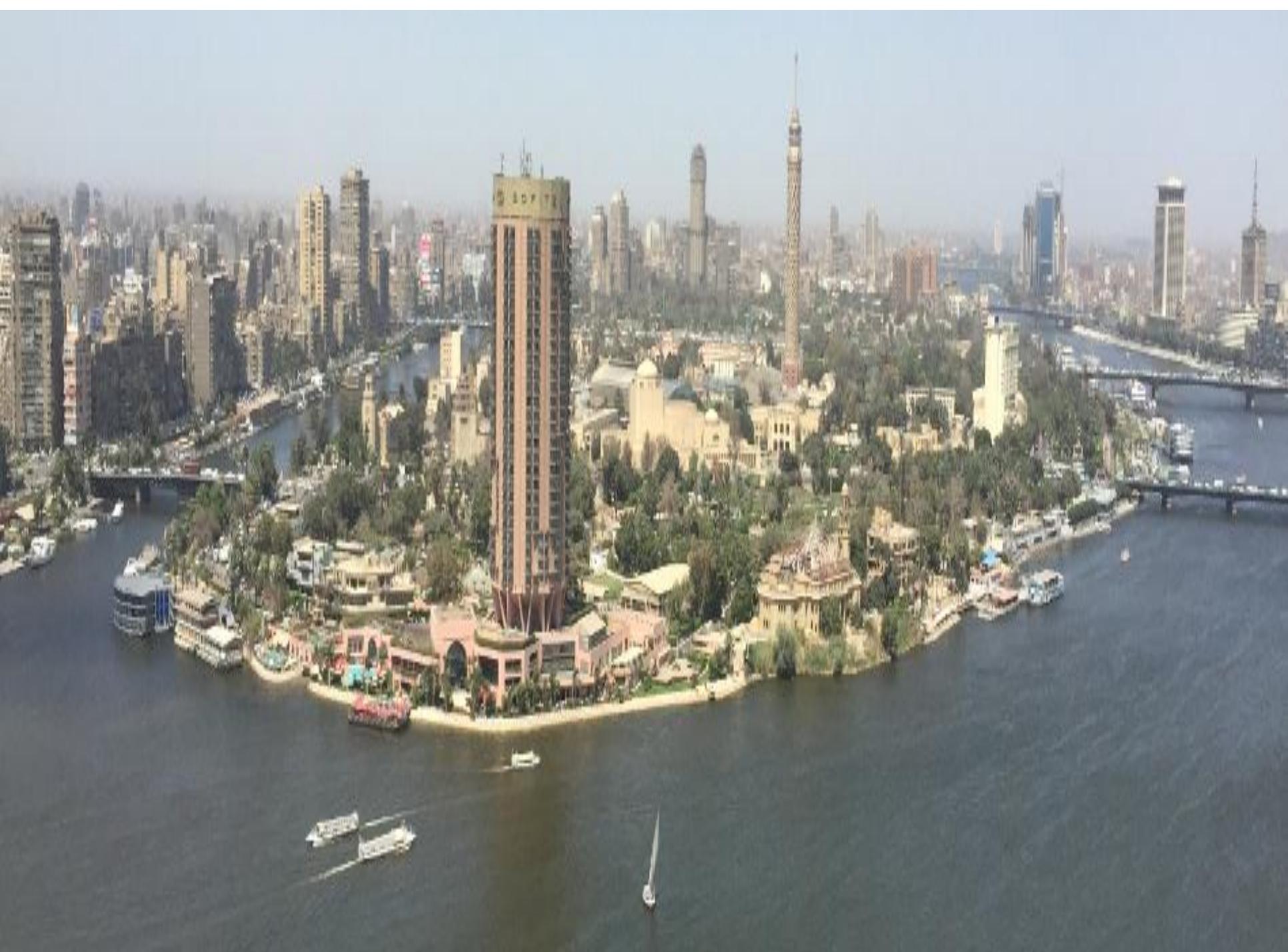
# Children with Hypertension in ED

By

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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 **≥95<sup>th</sup> 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  $>90^{\text{th}}$  percentile, **repeat twice** at same office visit before interpreting result.
- **Stage 1 hypertension:** SBP and/or DBP between the  $95^{\text{th}}$  percentile and **5 mmHg above the  $99^{\text{th}}$  percentile.**
- **Stage 2 hypertension:** SBP and/or DBP more than **5 mmHg above the  $99^{\text{th}}$  percentile.**

# Transient Hypertension

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

- Defined as an **asymptomatic** BP higher than the **95<sup>th</sup>** percentile **only once or twice**, but returning to less than the 95<sup>th</sup> 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 ↓	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
1	50th	85	84	85	88	89	89	90	92	93	94	95	95	96	97	97	98
1	90th	87	87	88	90	91	92	92	93	93	94	94	95	95	96	96	97
1	95th	100	101	102	104	105	106	107	108	108	109	109	110	110	111	111	112
1	99th	108	109	109	111	112	113	114	114	115	115	116	116	117	117	118	118
2	50th	85	85	87	89	89	91	91	92	93	94	94	95	95	96	96	97
2	90th	88	88	90	92	93	94	94	95	95	96	96	97	97	98	98	99
2	95th	102	103	104	106	107	108	109	109	110	110	111	111	112	112	113	113
2	99th	109	110	111	113	114	115	116	116	117	117	118	118	119	119	120	120
3	50th	88	87	88	89	91	92	92	93	94	94	95	95	96	96	97	97
3	90th	100	100	101	103	104	105	106	106	107	107	108	108	109	109	110	110
3	95th	104	104	105	107	108	109	110	110	111	111	112	112	113	113	114	114
3	99th	115	115	116	118	119	120	121	121	122	122	123	123	124	124	125	125
4	50th	88	88	90	91	92	94	94	95	96	96	97	97	98	98	99	99
4	90th	100	102	103	104	106	107	108	108	109	109	110	110	111	111	112	112
4	95th	105	106	107	109	110	111	112	112	113	113	114	114	115	115	116	116
4	99th	112	113	114	116	117	118	119	119	120	120	121	121	122	122	123	123
5	50th	89	89	91	92	94	95	95	96	97	97	98	98	99	99	100	100
5	90th	100	102	103	104	106	107	108	108	109	109	110	110	111	111	112	112
5	95th	107	107	108	110	111	112	113	113	114	114	115	115	116	116	117	117
5	99th	114	114	115	117	118	119	120	120	121	121	122	122	123	123	124	124
6	50th	91	92	93	94	96	97	97	98	99	99	100	100	101	101	102	102
6	90th	104	105	106	108	109	110	111	111	112	112	113	113	114	114	115	115
6	95th	108	109	110	111	113	114	115	115	116	116	117	117	118	118	119	119
6	99th	115	116	117	119	120	121	122	122	123	123	124	124	125	125	126	126
7	50th	92	93	94	96	97	98	98	99	100	100	101	101	102	102	103	103
7	90th	106	107	108	109	111	112	113	113	114	114	115	115	116	116	117	117
7	95th	112	113	114	115	117	118	119	119	120	120	121	121	122	122	123	123
7	99th	117	118	119	121	122	123	124	124	125	125	126	126	127	127	128	128
8	50th	93	94	96	98	99	100	101	101	102	102	103	103	104	104	105	105
8	90th	108	109	110	111	113	114	115	115	116	116	117	117	118	118	119	119
8	95th	112	113	114	115	117	118	119	119	120	120	121	121	122	122	123	123
8	99th	119	120	121	123	124	125	126	126	127	127	128	128	129	129	130	130
9	50th	94	95	98	100	101	102	103	103	104	104	105	105	106	106	107	107
9	90th	110	112	114	115	117	118	119	119	120	120	121	121	122	122	123	123
9	95th	116	118	119	120	122	123	124	124	125	125	126	126	127	127	128	128
9	99th	123	124	125	127	128	129	130	130	131	131	132	132	133	133	134	134
10	50th	95	96	100	102	103	104	105	105	106	106	107	107	108	108	109	109
10	90th	112	113	114	115	117	118	119	119	120	120	121	121	122	122	123	123
10	95th	118	119	120	121	123	124	125	125	126	126	127	127	128	128	129	129
10	99th	125	126	127	129	130	131	132	132	133	133	134	134	135	135	136	136

# 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	105	106	107	68	69	70	71	72	73	74	75
	90th	114	114	114	117	118	119	120	121	74	74	74	75	76	77	77	77
	95th	118	118	118	121	122	123	124	124	78	78	78	79	80	81	81	81
	99th	125	125	126	128	129	129	131	131	85	85	86	87	87	88	88	88
12	50th	100	101	101	102	103	104	105	106	69	70	71	72	73	74	74	74
	90th	114	114	117	118	120	121	122	123	75	75	75	76	77	77	78	78
	95th	118	120	121	122	124	125	126	126	79	79	79	80	81	82	82	82
	99th	127	127	128	130	131	132	133	133	86	86	87	88	88	89	89	89
13	50th	104	105	105	107	108	109	110	111	70	71	72	73	74	75	75	75
	90th	117	118	118	121	122	123	124	124	76	76	76	77	78	78	78	78
	95th	121	122	123	124	126	127	128	128	80	80	80	81	82	83	83	83
	99th	128	128	130	132	133	134	135	135	87	87	88	89	89	90	90	90
14	50th	104	105	107	108	110	111	112	113	70	71	72	73	74	75	75	75
	90th	118	120	121	122	124	125	126	126	77	77	77	78	79	79	80	80
	95th	123	123	125	126	127	128	129	129	81	81	81	82	83	84	84	84
	99th	130	131	132	133	135	136	136	136	88	88	89	90	90	91	91	91
15	50th	107	108	109	110	112	113	114	115	71	72	73	74	75	75	75	75
	90th	120	121	122	123	125	126	127	127	78	78	78	79	79	80	81	81
	95th	125	125	126	127	129	130	131	131	82	82	82	83	84	85	85	85
	99th	131	132	133	134	136	137	138	138	89	89	90	91	91	92	92	92
16	50th	108	109	110	111	113	114	115	116	71	72	73	74	75	75	75	75
	90th	121	122	123	124	126	127	128	128	78	78	78	79	80	81	81	81
	95th	125	126	127	128	130	131	132	132	82	82	82	83	84	85	85	85
	99th	132	133	134	135	137	138	139	139	90	90	90	91	92	93	93	93
17	50th	108	109	110	111	113	114	115	116	71	72	73	74	75	75	75	75
	90th	121	122	123	124	126	127	128	128	78	78	78	79	80	81	81	81
	95th	125	126	127	128	130	131	132	132	82	82	82	83	84	85	85	85
	99th	132	133	134	135	137	138	139	139	90	90	91	91	92	93	93	93

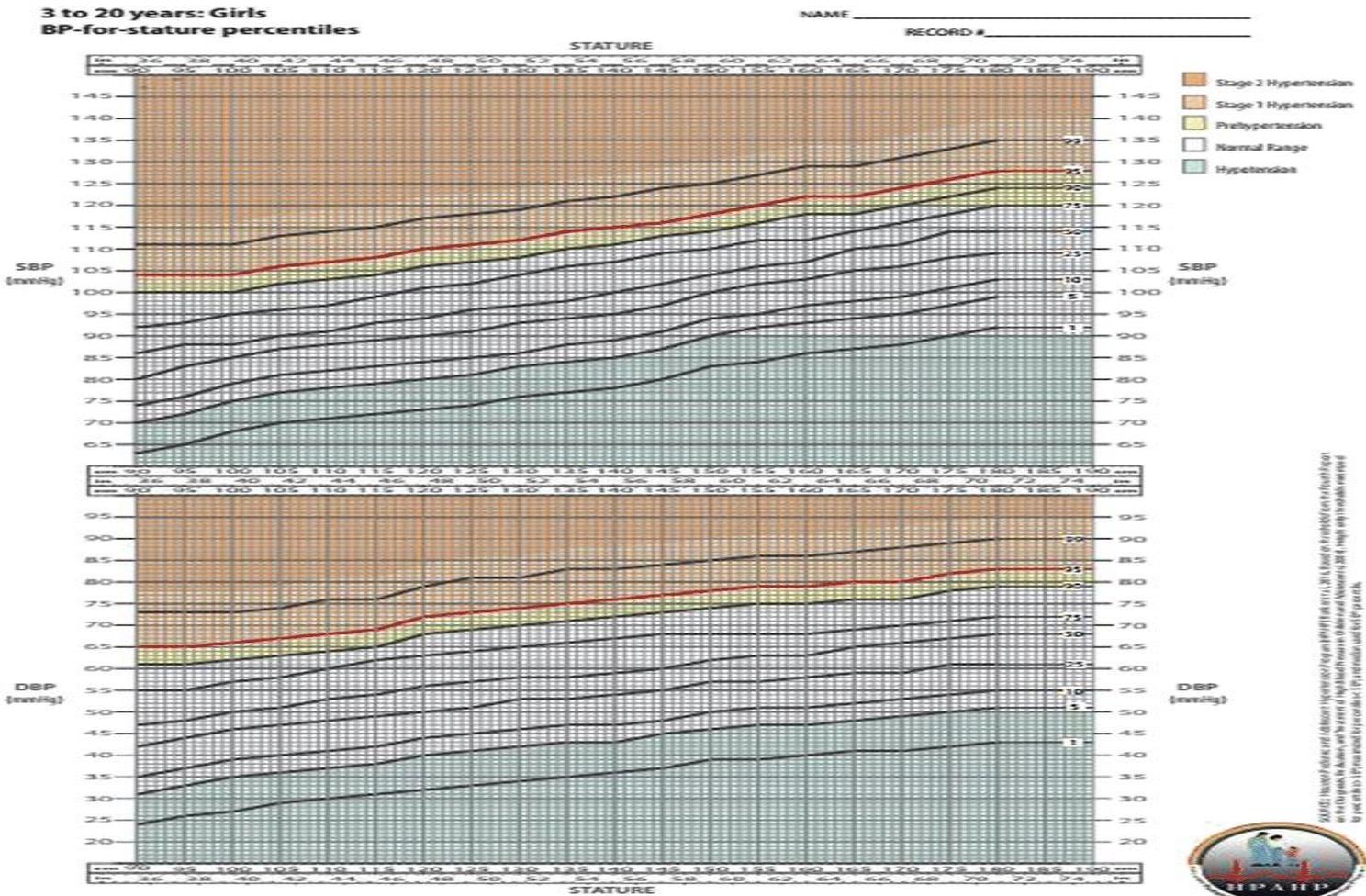
BP= blood pressure

\* The 50th percentile is 1.28 SD, 90th percentile is 1.645 SD, and the 99th percentile is 2.328 SD over the mean.

† For research purposes, the standard deviations in Appendix Table B-1 allow you 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 99th percentiles). These height percentiles must be converted to height Z-scores given by 25th = -1.96, 50th = -1.28, 75th = -0.675, 90th = 0, 95th = 1.645, 99th = 2.328, 99th = 3.090. Percentiles were computed according to the methodology in steps 2-4 described in Appendix B. For children with height percentiles other than those listed above in Appendix B.



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



# 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 paraganglioma
  - **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 99<sup>th</sup> percentile** **without** damage of target-organs.
- **Hypertensive Emergency:** an elevation in SBP and/or DBP **> 5 mmHg above the 99<sup>th</sup> 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

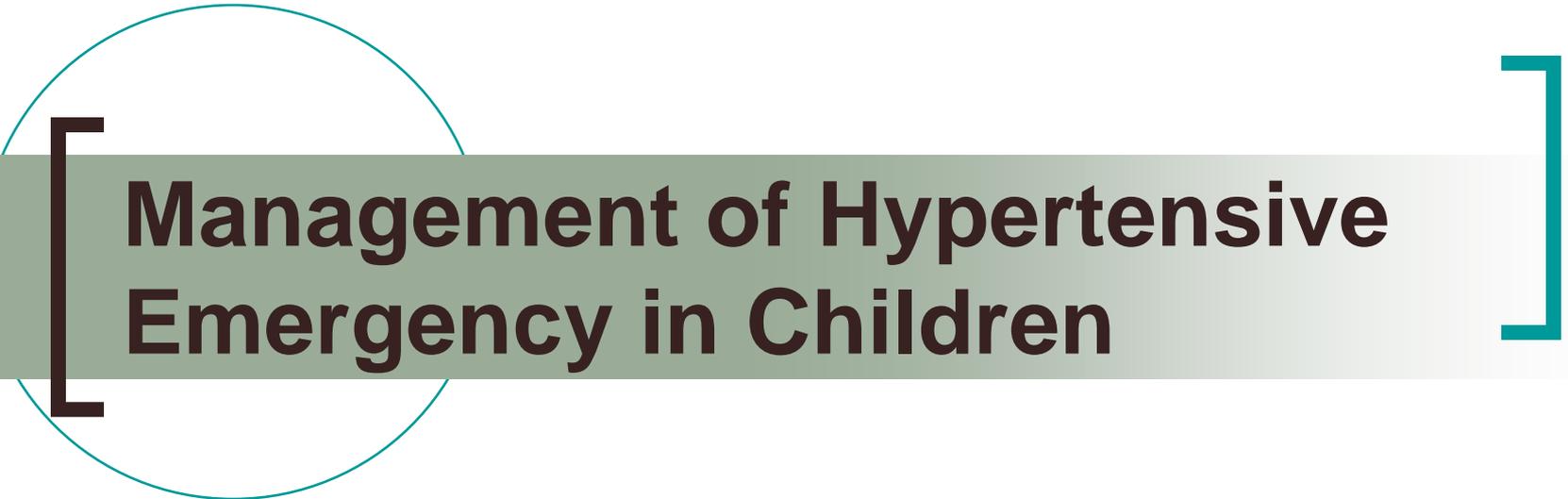
- Defined as **impairment** in renal, myocardial, hepatic, and hematologic functions, and neurological manifestations derived from HTN.
- **Acute (transient)** end organ damage is identified by abnormal clinical and laboratory findings which **subsides after a decrease in BP**.
- **Abnormal data includes:**
  - 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



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# 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
<b>Labetalol</b>	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: <b>asthma</b> , chronic lung disease, <b>heart failure</b> . May mask hypoglycemic symptoms.
<b>Nicardipine</b>	0.5–3.0 µg/kg/min	<b>IV infusion</b>	2-5 min	<b>30-60 min</b>	<b>May cause increased intracranial pressure</b> , headache, nausea, and hypotension.
<b>Hydralazine</b>	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. <b>Not as strong as other</b> agents. Recommended dose is less than U.S. Food and Drug Administration–approved label.
<b>Sodium nitroprusside</b>	0.3–8.0 µg/kg/min	<b>IV infusion</b>	<b>Seconds</b>	<b>During infusion only</b>	<b>Increase intracranial pressure</b> . <b>Monitor cyanide and thiocyanate</b> levels for patients with renal and liver disease when administering for >24–48 h.
<b>Esmolol</b>	100–500 µg/kg/min (initial dose), then 50–300 µg/kg/min	IV	<b>Seconds</b>	<b>10-20 min</b>	May cause <b>bronchospasm</b> , <b>congestive heart failure</b> , 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

