Hypertension in Children

Management of Hypertension

- How to measure BP
- When to measure BP
- Definitions
- Etiology
- Diagnosis
- Acute management
- Chronic management

Hypertension in Children

Management of Hypertension

- Silent killer
- WHO report: Hypertension Cause of:
- 62% of Cerebrovascular disease
- 49% of Ischemic heart disease
- 50% of causes of ESRF in adults
- Each 5mmHg increase in DBP:
- Increases risk:
- 20% coronary artery disease
- 35 % stroke

How to measure BP

In newborns:oscilometric، Flushing Method : MAP

In infants: Oscilometric, Mercury

Suitable cuff: 2/3 - 3/4 Arm Length, 2-3 Cm above elbow

Silent, at rest

Right hand

In Infants: Supine, Thereafter: Sitting position

Deflate: 2- 3mmHg/sec

Korrotcoff 1: Systolic

K2: Murmur

K3: Intensifies

K4: Muffling

K5: disappear: Diastolic

Cuff
Bladder
80-100% AC
>40% AC
AC

دور بازو
۸۰ درصد
۴۰ درصد
بلادر
کاف

Mean Blood Pressure

MAP = (Systolic-Diastolic)/3+Diastolic

MAP=Systolic+ 2 Diastolic/3

When to measure BP

Important part of vital signs

Children more than 3 years (Yearly, at health)

Emergency admission

ICU patients

When to measure BP

Children with risk factor:

Prematurity,anoxia,oligohydramnios

History of umbilical catheterization

Newborns with heart failure

Unexplained seizure

Abdominal bruit(Renovascular H.)

Abdominal mass (Wilm's=25-63%), Neuroblastoma

Coarctation of aorta

Neurofibromatosis(Fibromuscular dysplasia, 5% pheo.)

Turner(Coarct., Bicuspid aortic valve)

Congenital adrenal hyperplasia

Drugs: steroid, ACTH

Burns. HUS. FTT

Incidence

newborn 0/2%

Highrisk newborn 0/7-2/5%

- children 2-4%

  prehypertensive 10%
- Young adults: 15%
- 65 yrs: 60%
- Child BP > 90% → 2.4 fold increase in adulthood hypertension

Definitions & Classification

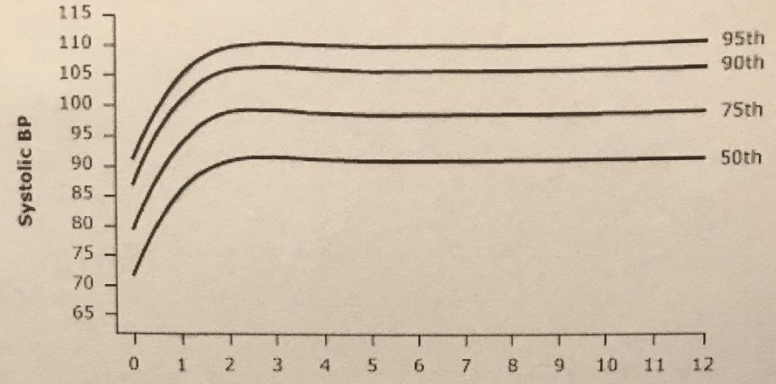
Product of Cardiac output and peripheral vascular resistance

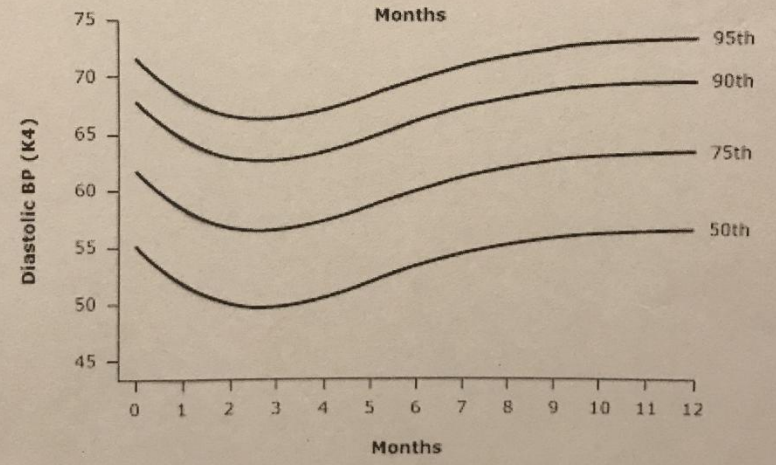
	For children aged 1 to <13 years)	For children aged ≥13 years
Normal BP	Systolic and diastolic BP <90th percentile	Systolic BP <120 and diastolic BP<80 mmHg
Elevated BP	Systolic and diastolic BP ≥ 90th percentile to <95th percentile, or 120/80 mmHg to < 95 percentile (whichever is lower)	Systolic BP 120 to 129 and diastolic BP<80 mmHg
Stage 1 HTN	Systolic and diastolic BP ≥ 95th percentile to <95th percentile+12 mmHg, or 130/80 to 139/89 mmHg (whichever is lower)	130/80 to 139/89 mmHg
Stage 2 HTN	Systolic and diastolic BP ≥ 95th percentile+12 mmHg, or ≥ 140/90 mmHg (whichever is lower)	≥ 140/90 mmHg

Blood pressure levels for boys by age and height percentile

BP (percentile)	Systolic BP (mmHg)							Diastolic BP (mmHg)						
	Height percentile or measured height							Height percentile or measured height						
	5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1 year														
Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	30.4	30.8	31.6	32.4	33.3	34.1	34.6
Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9	77.2	78.3	80.2	82.4	84.6	86.7	87.9
50th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
90th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
95th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
95th + 12 mmHg	114	114	115	115	116	117	117	66	66	67	67	68	69	69
2 years														
Height (in)	33.9	34.4	35.3	36.3	37.3	38.2	38.8	33.9	34.4	35.3	36.3	37.3	38.2	38.8
Height (cm)	86.1	87.4	89.6	92.1	94.7	97.1	98.5	86.1	87.4	89.6	92.1	94.7	97.1	98.5
50th	87	87	88	89	89	90	91	43	43	44	44	45	46	46
90th	100	100	101	102	103	103	104	55	55	56	56	57	58	58
95th	104	105	105	106	107	107	108	57	58	58	59	60	61	61
95th + 12 mmHg	116	117	117	118	119	119	120	69	70	70	71	72	73	73
3 years														
Height (in)	36.4	37.0	37.9	39.0	40.1	41.1	41.7	36.4	37.0	37.9	39.0	40.1	41.1	41.7
Height (cm)	92.5	93.9	96.3	99.0	101.8	104.3	105.8	92.5	93.9	96.3	99.0	101.8	104.3	105.8
50th	88	89	89	90	91	92	92	45	46	46	47	48	49	49
90th	101	102	102	103	104	105	105	58	58	59	59	60	61	61
95th	106	106	107	107	108	109	109	60	61	61	62	63	64	64
95th + 12 mmHg	118	118	119	119	120	121	121	72	73	73	74	75	76	76
4 years														
Height (in)	38.8	39.4	40.5	41.7	42.9	43.9	44.5	38.8	39.4	40.5	41.7	42.9	43.9	44.5
Height (cm)	98.5	100.2	102.9	105.9	108.9	111.5	113.2	98.5	100.2	102.9	105.9	108.9	111.5	113.2
50th	90	90	91	92	93	94	94	48	49	49	50	51	52	52
90th	102	103	104	105	105	106	107	60	61	62	62	63	64	64
95th	107	107	108	108	109	110	110	63	64	65	66	67	67	68
95th + 12 mmHg	119	119	120	120	121	122	122	75	76	77	78	79	79	80
5 years														
Height (in)	41.1	41.8	43.0	44.3	45.5	46.7	47.4	41.1	41.8	43.0	44.3	45.5	46.7	47.4
Height (cm)	104.4	106.2	109.1	112.4	115.7	118.6	120.3	104.4	106.2	109.1	112.4	115.7	118.6	120.3
50th	91	92	93	94	95	96	96	51	51	52	53	54	55	55
90th	103	104	105	106	107	108	108	63	64	65	65	66	67	67
95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
95th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
6 years														
Height (in)	43.4	44.2	45.4	46.8	48.2	49.4	50.2	43.4	44.2	45.4	46.8	48.2	49.4	50.2
Height (cm)	110.3	112.2	115.3	118.9	122.4	125.6	127.5	110.3	112.2	115.3	118.9	122.4	125.6	127.5
50th	93	93	94	95	96	97	98	54	54	55	56	57	57	58

Age-specific percentiles of BP measurements in boys - birth to 12 months of age; Korotkoff phase IV (K4) used for diastolic BP





90 th percentile													
Systolic BP	87	101	106	106	106	105	105	105	105	105	105	105	105
Diastolic BP	68	65	63	63	63	65	66	67	68	68	69	69	69
Height CM	51	59	63	66	68	70	72	73	74	76	77	78	80
Weight KG	4	4	5	5	6	7	8	9	9	10	10	11	11

BP: blood pressure.

Graphic 62371 Version 16.0

Definitions of Hypertension

- Risk of cardiovascular disease begins in 115/75
- Adolescents > 120/80 = Hypertension

Cut-off point for 95%:

1-5 years: 115/ 75

5- 10 years: 125/ 80

10- 15 years: 135/ 85

Severe hypertension

Severe hypertension traditionally been

divided into

hypertensive emergencies

hypertensive urgencies

Hypertensive emergency

An acute severe symptomatic elevation in BP with evidence of life-threatening symptoms or target organ damage (encephalopathy , heart failure, or renal disease)

Hypertensive urgency

An acute severe elevation in BP without life-threatening symptoms or evidence of acute target organ damage.

Definitions of severe Hypertension

Accelerated Hypertension:

Fundal changes, No papilledema

Malignant Hypertension:

Papilledema

Hypertensive Encephalopathy:

Diffuse brain dysfunction

Vomiting

Impaired consciousness

Seizure

Hypertensive retinopathy

Stage A :mild / presence generalized arteriolar narrowing , arteriovenous nicking, opacification of the arteriolar wall(copper wiring)

Stage B:mild/ focal arteriolar narrowing

Stage C&D: moderate/ multiple retinal hemorrhages and cotton wool patches.

Stage E&F: severe/ swelling of the optic disk , retinal hemorrhages , hard exudates and cotton wool patches.

Etiology of HTN

Primary HTN: No identifiable cause is found.

Secondary HTN: An underlying cause is identified.

Goals: Distinguish between primary and secondary

Distinguishing clinical features between primary and secondary pediatric HTN

Clinical features	Primary HTN	Secondary HTN
Age: Prepubertal postpubertal	 Older children and adolescents are more likely to have primary HTN	Secondary HTN is more likely in younger children especially those less than six years of age
Diastolic HTN		Diastolic HTN is more likely to be associated with secondary HTN
Nocturnal HTN		Nocturnal HTN is more likely to be associated with secondary HTN
Overweight / obesity	Overweight or obese children/adolescents are more likely to have primary HTN	
Family history of HTN	Children with positive family history of primary HTN are more likely to have primary HTN	Family history maybe positive in some cases of secondary HTN due to a monogenic cause(polycystic kidney)
Symptoms of underlying disorder	Typically asymptomatic	Symptoms related to the underlying cause(headache,sweating, tachycardia due to catecholamine excess in pheochromocytoma)

Causes of secondary Hypertension

Renal: Acute postinfectious glomerulonephritis(PSGN)

HSP, HUS, ATN, Renal Tx

Blood transfusion in azotemics

Hypervolemia, Pyelonephritis

Surgery in GU tract, Renal trauma

Leukemic infiltration of the Kidney

Obstructive uropathy

Causes of secondary Hypertension

Endocrine disease

Hyperthyroidism

Congenital adrenal hyperplasia

Cushing syndrome

Primary aldosteronism

Primary hyperparathyroidism

Diabetes mellitus

Hypercalcemia

Pheochromocytoma

Causes of secondary Hypertension

Vascular disease

Renal artery abnormalities

Renal vein thrombosis

Patent ductus arteriosus

Arteriovenous fistula

Coarctation of the aorta

Causes of secondary Hypertension

Drugs and poisons

Cocaine

Oral contraceptives

Sympathomimetics

Amphetamines

Phencyclidine

Steroids, ACTH

Cyclosporine, Sirolimus

Licorice

Lead, Mercury. Cadmium,

Vit D intoxication

Antihypertensive

withdrawal(Clonidin, Inderal,

Methyldopa

Causes of secondary Hypertension

- Central and autonomic nervous system
  - Increased ICP
  - Guillain Barre-Syndrome
  - Burns
  - Familial dysautonomia
  - Stevens-johnson syndrome
  - Posterior fossa lesions
  - Porphyria
  - Poliomyelitis
  - Encephalitis

Causes of secondary Hypertension

Miscellaneous: Fractures of long bones,

WBC transfusion,

Preeclampsia, After Coarctation repair, ECMO, Chronic upper airway obstruction

Acute pain,

Collagen vascular disease

Etiology of Hypertension

In adults:
General population: 92-94% Essential
Referral clinics: 65-85% Essential
In children:
> 10 years: Mostly Essential hypertension
< 6 - 8 years: Usually secondary
1- Renal or Azotemic Hypertension: 75-80%
2- Renin mediated: 10-15%
3- Mineralocorticoid induced: 3-5%
4- Cathecolamine induced: 2-5%

Renal, Azotemic Hypertension

Abnormal U/A: Hematuria, Proteinuria
RBC, WBC Cast, Low SG, PH

Electrolyte: High Urea, Creatinine
Edema, oliguria

Glomerulonephritis:

Low C3:
PSGN Most common)
MPGN
Lupus
Chronic infection

Consider Biopsy

Chronic pyelonephritis: 25-50%

CRF, HUS, HSP, RTX

Renin mediated Hypertension

|- Cardiovascular : Coarctation

'(Measure BP in Hands &Foot)

II- Renovascular hypertension

Characteristics:

1-Hypokalemic metabolic alkalosis

2- End organ damage

(proteinuria Hematuria Fundal exam)

3-Malighant hypertension (Diastolic)

4- Refractory to treatment

Mineralocorticoid induced Hypertension

Systolic BP: High

Diastolic BP: Mildly elevated- Normal

UIA: Normal

No Edema

No end organ damage

Electrolyte: Hypokalemia - Metabolic alkalosis

Aldosterone: High

Renin: Low

CT scan: Adrenal tumor, Hyperplasia

Treatment: Spironolacton, Surgery(Tumor excision)

Pseudohyperaldosteronism: Liddle's syndrome

Catecholamine induced Hypertension

Malignant Hypertension: Very high BP (Constant)
Most common cause: Head and Neck surgery
Pheochromocytoma
5% of Neurofibromatosis develop Pheochromocytoma
Test: Epinephrine Nore epinephrine(Fasting blood)
U/S, CT scan, MIBG scan
No Metabolic Alkalosis
Therapy: Alpha blocker= Phenoxybenzamine, Phentolamine
Intermittent High BP:
Guillain-Barre syndrome
Poliomyelitis
Burns
Stevens-Johnson syndrome
Familial Dysautonomia

Etiology of Hypertension based on age

Newborn - 6 month:

1-Renovascular

(Umbilical catheterization)
(Fibromuscular dysplasia)

2- Cardiovascular

(Coarctation of aorta)
(Congenital heart disease: Cyanotic, Acyanotic))

3. Congenital Kidney diseases

(Hypoplastic,dysplastic)
(Agenesis, Hydronephrosis)
(Cystic lesion: Infantile, Adult types),

4- CNS disorder

(Intracranial Hemorrhage, SOL, Meningitis)

5- Bronchopulmonary dysplasia

Etiology of Hypertension based on age

Infancy - 6 years

1- Parenchymal renal diseases

2- Renovascular

3- Coarctation of Aorta

Etiology of Hypertension based on age

Six to 10 years:

1- Renal (Parenchymal - Vascular)

2- Essential Hypertension

Etiology of Hypertension based on age

After 13 years:

1-Essential Hypertension

Parenchymal renal diseases

Clinical Manifestations of Hypertension

- **Nonspecific symptoms:**

Headache
Fatigue
Sleep disturbance

- **Severe Hypertension:**

Severe Headache
Visual changes
Chest pain
Epistaxis
+Underlying disease symptoms
LVH most common end organ abnormality:
in 34-38% of children with Hypertension

Hypertensive Emergency:

- **Clinical manifestations:**
- Hypertensive encephalopathy
- Congestive heart failure
- Pulmonary edema
- Acute renal failure
- Stroke
- Myocardial infarction
- Adrenergic crisis
- Dissecting aortic aneurism
- Eclampsia
- Head trauma

Diagnostic approach to cause of Hypertension

Family History:
Essential hypertension, Familial pheo.
Personal History:
Umbilical catheterization
Dyauria, Frequency:
Renal Hypertension
Drug:
Sympathomimetic, Steroids, Lead, Mercury
Cramp, Weakness
Hypokalemia (Primary hyperaldosteronism)
Physical Exam:
Edematous, Pale=Renal
Web Neck= Turner
Cafe o' Lait= Neurofibromatosis
Abdominal bruit= Reno vascular Hypertension

Screening tests

Routin: In all patients

CBC, Diff

Anemia= CRF Eosinophilia= Interstitial Neph.

UIA, U/C

Nephritis, Chronic pyelonephritis

Electrolyte

Hypokalemia+ Met. Alkalosis

(Renin mediated, Hyperaldosteronism

BUN, Cr

ECG, ECHO

Chronicity

Uric acid, Lipids

>6- 10 year Essential Hypertension

Treatment of hypertensive emergency

- 25% reduction in first hr
- 25% reduction in first 8 hr
- 1/3 reduction in first 6-8 hr
- Not achieving below 95% before 24-48 hr
- **Excessive reduction lead to:**

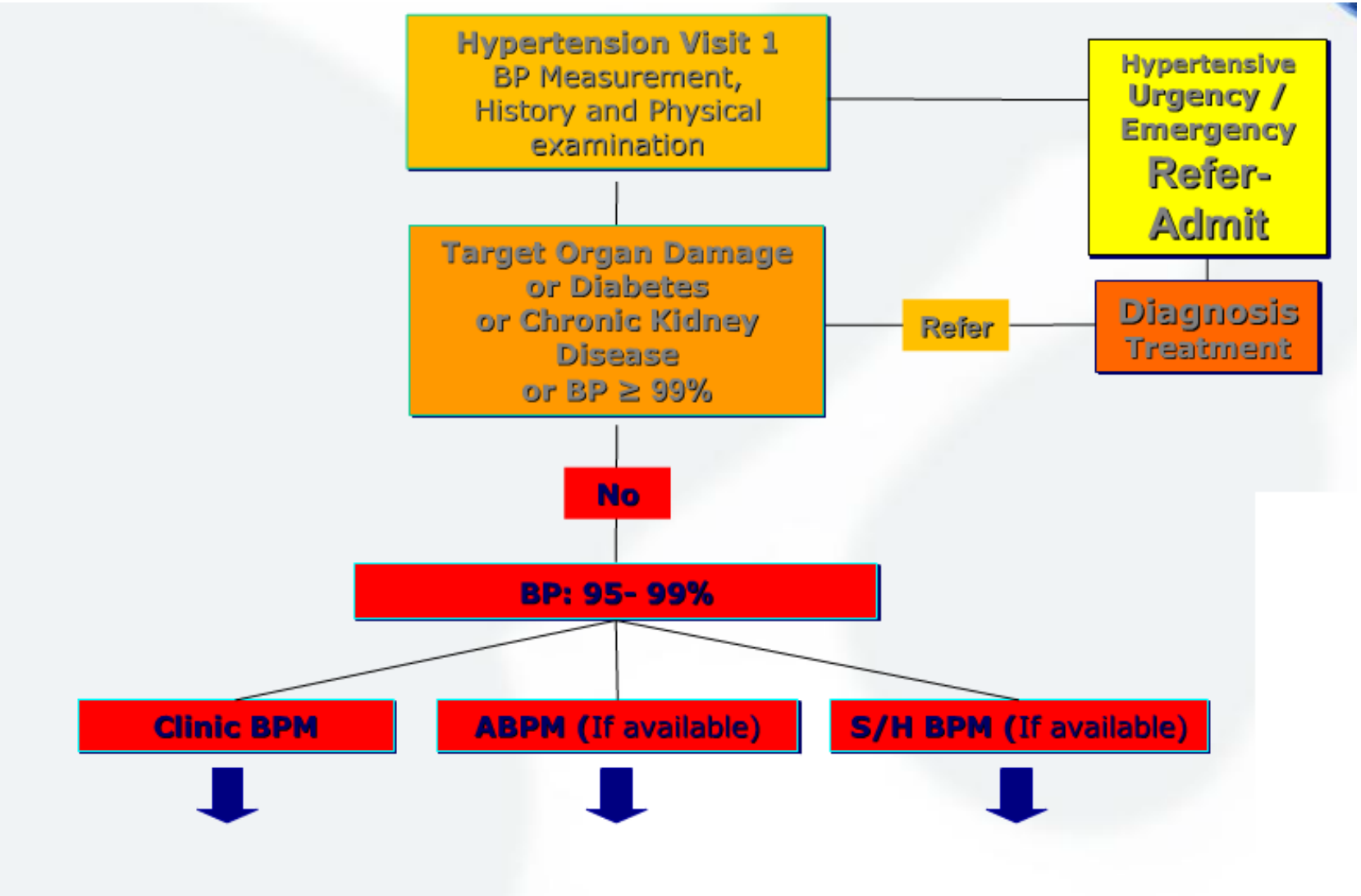
*Diminished cerebral blood flow

*** Syncope**

*Infarction of:

*cerebral cortex, brainstem and retina

Diagnostic algorithm for Hypertension



Treatment of hypertension

- Non-pharmacologic Treatment:
- **Exercise:** 3-6 month:

→ **Reduces BP 6-12/3-5**

- 40-60 Min/Session
- 4-5 times/week
- **Nutrition:** Low salt, High K, Ca
- **Weight reduction:**
- Fatness: Last 30 yrs from 5% + 15%

Pharmacologic Treatment of hypertension

1. • Diuretics
2. • Beta blockers
3. • ACE inhibitors
4. • Angiotensin Receptor Blockers
5. • Calcium Channel Blockers
6. • Alpha 1 Blockers
7. • Centrally acting Alpha2 agonists
8. • Direct Vasodilators
9. • Peripherally acting adrenergic antagonists

Treatment guidelin hypertension

Azotemic Hypertension

High Intravascular Volume:

Periferal vascular resistance

Renin medited

Unilateral

Hyperaldostronism

Catechole induced

Furosemide

Hydralazine- Nifedipine
Propranolol

Captopril
Enalaprilat- Enalapril
Labetolol
Aldactone

Phentolamine
Phenoxybenzamine
Prazosin- Propranolol- Labetolo

Management of hypertension

Acute management:

Direct Vasodilators:

- **Nitroprusside:**
- **Diazoxide:**
- **Hydralazine**
- **Nifedipine**
- **Labetolol:**

Chronic management:

Treatment of Sudden and Severe hypertension:

- **Nitroprusside:** 0.3-8ug/kg/min or
- **Labetolol:** 0.2-1 mg/kg/dose IV over 2 min repeat every 5-10 min, max dose 60 mg
- **Diazoxide:** 1-3 mg/kg IV over 5-10 min
- **Nifedipine: 0.25** mg/kg/dose
- **Hypertensive encephalopathy:**
- **Nitroprusside:** 0.3-8ug/kg/min or
- **Labetolol:** 0.2-1 mg/kg/dose IV over 2 min
- **Nicardipine:** 0.5-5ug/kg/min or
- **Diazoxide:** 1-3 mg/kg IV over 5-10 min

Treatment of Hypertensive Emergency in Head trauma or Intracranial hemorrhage:

Nitroprusside or

Labetolol:

Do not use:

Diazoxide

Nicardipine

Hydralazine

Treatment of Hypertensive Emergency in Catecholamine production:

Phentolamine:

0.1-0.2 mg/kg/IV bolus (max 5mg)

Repeat every 2-4 hr

May give 1-2 hr before surgery

Chronic management of Hypertension

Diuretics

Thiazides:

Hydrochlorothiazides: (1-2mg/kg)(Tab 50mg)
Proximal, Early distal
Side effects: Hypokalemia, Hyperglycemia, Hypercalcemia, Hyperuricemia
Loop diuretics: (1-2mg/kg/dose BD)(Tab. 40mg)

Eurosemide

Side effects:
Hypokalemia (Suitable for In renal failure)
Autotoxicity less than

Ethacrinic acid

Antikaiuretics:

Spironolactone(1-3mg/kg/d)(Tab. 25mg)
Triamtrene, Amiloride: Distal tubule:
Triamtrene-H =(Triamtrene 50mg, Hydrochlorothiazide 25mg)

Chronic management of Hypertension-cont.

Adrenergic Blockers

Alpha Blockers:

Prazosin, Phentolamine, Phenoxybenzamine

Beta Blockers(1-2mg/kg/d):

Propranolol(reduces Renine release)

B1 Blockers: Atenolol, Metoprolol

Limitations:

Asthma(Bronchospasm)

Congestive Heart failure

Diabetics(Masks signs of Hypoglycemia

Lipid changes

Vasodilatators:

Hydralazine, Minoxidil(Potent, Hirsutism)

Algorithm for management of Hypertension