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Review Articles

Hypertension in the Children: A Review

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Introduction:

Hypertension in the Children is increasingly being recognized as an emerging critical healthcare problem, because of its increasing prevalence in recent years and also of its significant impact on the health and well-being of children and adolescents and tracking into adult life.[1] Pediatric hypertension has unique features that differentiate it from hypertension in adults. It is widely accepted that childhood hypertension provides an increased risk for future cardiovascular morbidity and mortality.[2] Over the past two decades hypertension in children and adolescents seems to be increasing. This is attributed at least in part to an increased prevalence of overweight in this population. While most childhood hypertension has been previously considered secondary to renal, cardiovascular or endocrine etiology, a substantial number of children aged 6 to 20 years are now diagnosed with primary or essential hypertension.[3,4] Hypertension is a known risk factor for coronary artery disease (CAD) in adults, and the presence of childhood hypertension may contribute to the early development of CAD. Reports show that early development of atherosclerosis does exist in children and young adults and may be associated with childhood hypertension.[5]

Left ventricular hypertrophy (LVH) is the most prominent clinical evidence of end-organ damage in childhood hypertension. Data show that LVH can be seen in as many as 41 percent of patients with childhood hypertension. Patients with severe cases of childhood hypertension are also at increased risk of developing hypertensive encephalopathy, seizures, cerebrovascular accidents, and congestive heart failure. Based on these observations, early detection and intervention in children with hypertension are potentially beneficial in preventing long-term complications of hypertension.[5]

Epidemiology:

The true incidence of hypertension in the pediatric population is not known. This vagueness partly stems from the somewhat arbitrary definition of hypertension. Studies have not been performed in children, although reports from small populations of children provided compelling evidence of relationship between hypertension and both ventricular hypertrophy and atherosclerosis. Children who are obese have approximately a 3-fold higher risk for hypertension that children who are not obese.[6] The epidemic of overweight and obesity in youth is increasing the prevalence of hypertension among children and adolescents.[7,8] In both developed and developing countries childhood obesity continues to increase and in association with hypertension, dyslipidemia and diabetes mellitus forms the 'metabolic syndrome' The prevalence of hypertension in obese children is much higher at 11-30% with improvement in BP on weight reduction and increased activity.[9]

Obesity in childhood also results in numerous sequelae and comorbidities such as hepatic disease, orthopedic problems and psychosocial disorders. From a cardiovascular standpoint, numerous studies over the years have firmly established the link between increased BMI and increased BP in children and adolescents. In numerous school screening studies conducted in the United States over the past several years, most notably in Houston, TX, the prevalence of hypertension in adolescents has been shown to be as high as 10% among those with BMI >97th percentile. Strong associations between overweight and elevated BP have also recently been reported in sixth-graders in Seminole County, FL14 and in even younger children in Anadarko, OK.[10]

There are insufficient data that define the role of race and ethnicity in childhood hypertension, although results of several studies show black children having

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higher blood pressure than white children. Heritability of childhood hypertension is estimated at 50 percent. One report noted that 49 percent of patients with primary childhood hypertension had a relative with primary hypertension, and that 46 percent of patients with secondary childhood hypertension had a relative with secondary hypertension. Another report showed that in adolescents with primary hypertension there is an overall 86 percent positive family history of hypertension.[5]

No significant differences are observed in BP between girls and boys younger than 6 years. From that age until puberty, BP is slightly higher in girls than boys. At puberty and beyond, BP is slightly higher in male adolescents and men than in comparably aged female adolescents and women.[6] Height and weight affect BP. However, these relationships do not become evident until children are school aged.[7]

Risk factors:

The risk factors for high blood pressure are very similar for both adults and children. Obesity, exercise level, genetic traits, and family history all play an important role. Even though the actual risk factors are as same as adult they tend to work differently - some are more important, some are less important - and there is no universally accepted way to calculate total risk in children. Following factors should be considered:

1. Body weight and Body Mass Index

Increasing body weight and body mass index are reliable signals indicating increased risk of developing high blood pressure.

2. Socio-Economic Factors

Many studies have found that pediatric population from low socio-economic backgrounds has an increased risk of health problems, including high blood pressure.

3. Ethnicity

Bogalusa Hearth Study[4] - seemed to show different blood pressure risk trends between black and white children, but several later studies have been unable to replicate the results, showing no risk difference between the two groups.

4. Family History:

Family history appears to play a strong role in a child's risk of developing high blood pressure. Some researchers have estimated that about 70% of the cases of high blood pressure in a family are a direct result of genetics[4].

5. Breastfeeding

Two studies involving more than 15,000 children have found that children who are breastfed appear to have a lower risk of developing high blood pressure early in life. On average, these children had systolic blood pressures that were about 1.2 mmHg lower than bottle fed children. Diastolic pressure was also lower, but systolic pressure continued to show a decreasing trend for as long as breast feeding continued[4].

Other risk factors for high blood pressure depend on underlying health conditions, genetics or lifestyle factors[4]. Recent data shows that low birth weight, prematurity and uric acid levels are associated with hypertension early in childhood and in young adult life, not just in later adult life. Reduction of dietary salt intake leads to significant reductions in blood pressure in infants and young children. Elevated uric acid levels play a key role in essential hypertension by contributing to endothelial dysfunction leading to microvascular and inflammatory injury to the kidney.[9]

Definition And Classification Of Hypertension:

According to the criteria of the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure (BP) in Children and Adolescents, normal BP in children is defined as Systolic BP (SBP) and Diastolic BP (DBP) less than 90th percentile for age, sex and height, whereas hypertension is defined as SBP and/or DBP persistently 95th percentile or more, measured on at least three separate occasions with the auscultatory method. Children with average SBP or DBP 90th percentile or more but less than 95th percentile are classified as having high-normal BP. Adolescents with BP 120/80 mmHg or more even if less than 90th percentile are also considered as having high-normal BP (Table-I).

Additionally, the Fourth Report provides criteria for staging the severity of hypertension in children and adolescents which can then be used clinically to guide evaluation and managements. Stage 1 hypertension is defined as BPs from the 95th percentile to the 99th percentile plus 5 mmHg. Stage 2 hypertension denotes any BP above the 99th percentile plus 5 mmHg. Children or adolescents with stage 2 hypertension should be evaluated and treated more quickly and/or intensively than those with a lower degree of BP elevation.[11]

Table-I

Definition and classification of hypertension in children and adolescents[11]

Class	SBP and/or DBP percentile
Normal	<90th
High-normal	>90th to < 95th > 120/80 even if below 90th percentile in adolescents
Stage 1 hypertension	95th percentile to the 99th percentile plus 5 mmHg
Stage 2 hypertension	>99th percentile plus 5mmHg

Modified from Task Force on High Blood Pressure in Children and Adolescents. The term pre hypertension has been changed to 'high-normal' according to the ESH/ESC guidelines 2007.

The term white-coat hypertension defines a clinical condition in which the patient has BP levels that are >95th percentile when measured in physician's office or clinic, whereas the patient's average BP is <90th percentile outside of a clinical setting. Ambulatory BP monitoring (ABPM) is usually required to make this diagnosis.[12] Evidence that white-coat hypertension is potentially a pre hypertensive state in some children comes from a retrospective study of 119 patients aged 6-18 years old by Kavey et al.[12]

Blood Pressure Measurement:

According to the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (NHBPEP) recommendations, children three years of age or older should have their blood pressure measured when seen at a medical facility. The preferred method for blood pressure measurement is auscultation. Aneroid manometers are used to measure blood pressure in children and are accurate when calibrated on a semiannual basis. Correct measurement of blood pressure in children requires use of a cuff that is appropriate to the size of the child's upper right arm. This is the preferred arm because of the possibility of decreased pressures in the left arm caused by coarctation of the aorta. By convention, an appropriate cuff size is one with an inflatable bladder width that is at least 40 percent of the arm circumference at a point midway between the olecranon and the acromion. The cuff bladder length should cover 80 to 100 percent of the circumference of the arm. An oversized cuff can underestimate the blood pressure, whereas an undersized cuff can overestimate the measurement.[5]

Ideally, the child whose BP is to be measured should have avoided stimulant drugs or foods, have been sitting quietly for 5 minutes, and seated with his or her back supported, feet on the floor and right arm supported, cubital fossa at heart level. A stethoscope placed over the brachial artery pulse, proximal and medial to the cubital fossa, and below bottom edge of the cuff (ie, ~2 cm above the cubital fossa). SBP is determined by the onset of the "tapping" Korotkoff sounds (K1). Population data in children and risk-associated epidemiologic data in adults have established the fifth Korotkoff sound (K5), or the disappearance of Korotkoff sounds, as the definition of DBP.

Oscillometric devices measure mean arterial BP and then calculate systolic and diastolic values must be validated on a regular basis. Two advantages of automatic devices are their ease of use and the minimization of observer bias or digit preference. Use of the automated devices is preferred for BP measurement in newborns and young infants, in whom auscultation is difficult, and in the intensive care setting, in which frequent BP measurement is needed.

Table-II

Recommended Dimensions for BP Cuff Bladders[13]

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 arm by at least 80%.

Table-III

Conditions under which children <3 years old should have BP measured[13]

History of Prematurity, very low birth weight, or other neonatal complication requiring intensive care
Congenital heart disease (repaired or non repaired, e.g. Coarctation of aorta)
Recurrent urinary tract infections, hematuria, or proteinuria
Known renal disease or urologic malformations
Family history of congenital renal disease
Solid-organ transplant
Malignancy or bone marrow transplant
Treatment with drugs known to raise BP
Other systemic illnesses associated with hypertension (neurofibromatosis, tuberous sclerosis, etc)
Evidence of elevated intracranial pressure.

Ambulatory Blood Pressure Monitoring (ABPM)

ABPM refers to a procedure in which a portable BP device, worn by the patient, records BP over a specified period, usually 24 hours. ABPM is very useful in the evaluation of hypertension in children. ABPM is especially helpful in the evaluation of white-coat hypertension as well as the risk for hypertensive organ injury, apparent drug resistance, and hypotensive symptoms with antihypertensive drug. ABPM is also useful for evaluating patients for whom more information on BP patterns is needed, such as those with episodic hypertension, chronic kidney disease, diabetes, and autonomic dysfunction.[13] ABPM also may have a role in differentiating primary from secondary hypertension.[5] ABPM devices allow assessment of SBP and DBP, expressed as mean values during 24 h, daytime and nighttime periods. BP load and 'dipping status' can also be assessed on ABPM. Masked hypertension is defined as normal clinic BP but with either systolic or diastolic daytime ABP values greater than or equal to the 95th percentile for sex and height.[9]

Etiologies:

Most childhood hypertension, particularly in preadolescents, is secondary to an underlying disorder. Renal parenchymal disease is the most common (60 to 70 percent) cause of hypertension. Other causes include endocrine disease (e.g., pheochromocytoma, hyperthyroidism) and pharmaceuticals (e.g., oral contraceptives, sympathomimetics, some over-the-counter preparations, dietary supplements). Transient rise in blood pressure, which can be mistaken for hypertension, is seen with caffeine use and certain psychological disorders (e.g., anxiety, stress). Adolescents usually have primary or essential hypertension, making up 85 to 95 percent of cases. Essential hypertension rarely is found in children younger than 10 years and is a diagnosis of exclusion. Significant risk factors for essential hypertension include family history and increasing BMI. Some sleep disorders and black race can be potential risk factors for essential hypertension. Essential hypertension often is linked to other risk factors that make up metabolic syndrome and can lead to cardiovascular disease. The prevalence of metabolic syndrome among adolescents is between 4.2 and 8.4 percent.[5]

Diagnosis:

In addition to a thorough clinical history, physical examination and laboratory and radiological investigations, the initial work up for a child with suspected hypertension should be targeted towards confirming hypertension, identifying comorbidities and looking for the presence of target organ damage.[9] With the appropriate information, unnecessary and often expensive laboratory and imaging studies can be avoided.[5]

Table-IV

Common Causes of Hypertension by Age[14]

Infants	Children	Adolescents	
	1-6 y	7-12 y	
Thrombosis of renal artery or vein	Renal artery stenosis	Renal parenchymal disease	Essential hypertension
Congenital renal anomalies	Renal parenchymal disease	Renovascular abnormalities	Renal parenchymal disease
Coarctation of the aorta	Wilms tumor Neuroblastoma	Endocrine causes	Endocrine causes
Bronchopulmonary dysplasia	Coarctation of the aorta	Essential hypertension	

Table-V

Examples of Physical Examination Findings Suggestive of Definable Hypertension[13]

	Finding*	Possible Etiology
Vital signs	Tachycardia	Hyperthyroidism, pheochromocytoma, neuroblastoma, primary hypertension
	Decreased lower extremity pulses; drop in BP from upper to lower extremities R	Coarctation of the aorta
Eyes	Retinal changes	Severe hypertension, more likely to be associated with secondary hypertension
Ear, nose, arid throat	Adenotonsillar hypertrophy	Suggests association with sleep-disordered breathing (sleep apnea), snoring
Height/weight	Growth retardation	Chronic renal failure
	Obesity (high BMI)	Primary hypertension
	Truncal obesity	Cushing syndrome, insulin resistance syndrome
Head and neck	Moon facies	Cushing, syndrome
	Elfin facies	Williams syndrome
	Webbed neck	Turner syndrome
	Thyromegaly	Hyperthyroidism
Skin	Pallor, flushing, diaphoresis	Pheochromocytoma
	Acne, hirsutism, striae	Cushing syndrome, anabolic steroid abuse
	Café-au-lait spots	Neurofibromatosis
	Adenoma sebaceum	Tuberous sclerosis
	Malar rash	Systemic lupus erythematosus
	Acanthrosis nigricans	Type 2 diabetes
Chest	Widely spaced nipples	Turner syndrome
	Heart murmur	Coarctation of the aorta
	Friction rub	Systemic lupus erythematosus (pericarditis), collagen-vascular disease, end stage renal disease with uremia
	Apical heave	LVH/chronic hypertension
Abdomen	Mass	Wilms tumor, neuroblastoma, pheochromocytoma
	Epigastric/flank bruit	Renal artery stenosis
	Palpable kidneys	Polycystic kidney disease, hydronephrosis, multicystic-dysplastic kidney, mass (see above)
Genitalia	Ambiguous/ virilization	Adrenal hyperplasia
Extremities	Joint swelling	Systemic lupus erythematosus, collagen vascular disease
	Muscle weakness	Hyperaldosteronism, Liddle syndrome

History and Physical Examination

The child with primary hypertension often has a positive family history of hypertension or cardiovascular disease. Other risk factors including metabolic syndrome and sleep-disordered breathing (from snoring to obstructive sleep apnea) also are associated with primary hypertension. A careful history will uncover these important elements. It is helpful to remember that secondary hypertension is more likely in a younger child with stage 2 hypertension, thus data about systemic conditions associated with elevated blood pressure should be elicited. Because most secondary hypertension is renovascular in origin, a focused review of that system may provide insight into the possible etiology. A medication history should include any use of over-the-counter, prescription, and illicit drugs, because many medications and drugs can elevate blood pressure. The physician should also ask about the use of performance-enhancing substances, herbal supplements (e.g., ma huang), and tobacco use.[5]

Physical examination should include calculation of BMI because of the strong association between obesity and hypertension. Obtaining blood pressure readings in the upper and lower extremities to rule out coarctation of the aorta also is recommended. Examination of the retina should be included to assess the effect of hypertension on an easily accessed end organ. In the majority of children with hypertension, however, the physical examination will be normal.[5] But some signs and symptoms that should alert the physician to the possibility of hypertension include the following[10]:

1. Neonates
   a. Failure to thrive
   b. Seizure
   c. Irritability or lethargy
   d. Respiratory distress
   e. Congestive heart failure

2. Children (Findings in addition to those observed in neonates)
   a. Headache
   b. Fatigue
   c. Blurred vision
   d. Epistaxis
   e. Bell palsy

Laboratory and Imaging Tests:

Laboratory testing and imaging on a child with hypertension should screen for identifiable causes, detect comorbid conditions, and evaluate end-organ damage. Screening tests should be performed on all children with a confirmed diagnosis of hypertension.

In addition to the diagnostic tests already mentioned, an assessment of end-organ damage must be made. Retinopathy, microalbuminuria, and increased carotid artery thickness have all been reported in children with primary hypertension. Documenting LVH is an important component of the evaluation of children with hypertension. Because echocardiography is noninvasive, easily obtained, and more sensitive than electrocardiography it should be part of the initial evaluation of all children with hypertension and may be repeated periodically.[5]

Table-VI

Laboratory investigations[11]

1)	*Routine tests that have to be performed in all hypertensive children*
	a) Full blood count
	b) Plasma sodium, potassium and calcium, urea, creatinine
	c) Fasting plasma glucose
	d) Serum lipids (cholesterol, LDL, HDL)
	e) Fasting serum triglycerides
	f) Urinalysis plus quantitative measurement of micro-albuminuria and proteinuria
	g) Renal ultrasound
	h) Chest X-ray, ECG and 2-D echocardiography
2)	Recommended additional screening tests
	a) Plasma renin activity, plasma aldosterone concen-tration
	b) Urine and plasma catecholamines or metanephrines
	c) Tc99 dimercaptosuccinic acid scan,
	d) Urinary free cortisol
3)	*More sophisticated tests that should await results of above screening*
	a) Color Doppler ultrasonography
	b) Captopril primed isotope studies
	c) Renal vein renin measurements
	d) Renal angiography
	e) I^{123} metaiodobenzylguanidine scanning
	f) Computed tomography/ Magnetic resonance ima-ging
	g) Urine steroid analyses and more complex endocrine investigations
	h) Molecular genetic studies (Apparent mineralo-corticoid excess, Liddle's syndrome, etc).

Management:

Careful clinical assessment is the key tool for identifying secondary causes or a predisposition to primary hypertension, with laboratory testing reserved if a specific underlying cause is

suspected. Management is directed at secondary causes, and general cardiovascular risk reduction is aimed at dietary modification, increased exercise and attainment or maintenance of ideal body weight. Institution of drug therapy depends on the degree of hypertension and the risk of future end-organ damage or cardiovascular disease.[14] End-organ damage, comorbid conditions, and associated risk factors also influence decisions about therapy.

Nonpharmacologic and pharmacologic treatments are recommended based on the age of the child, the stage of hypertension, and response to treatment.

Nonpharmacologic Treatments:

For children and adolescents with high-normal or stage 1 hypertension, therapeutic lifestyle change is recommended. These include weight control, regular exercise, a low-fat and low sodium diet, smoking cessation, and abstinence from alcohol use.

Obesity increases the occurrence of hypertension threefold while favoring the development of insulin resistance, hyperlipidemia, and salt sensitivity. Significant obesity also increases the likelihood of left ventricular hypertrophy (LVH) independent of blood pressure level. Exercise has been shown to lower blood pressure in children, but does not affect left ventricular function. Participation in competitive sports are permitted for children with high-normal, stage 1 hypertension, or, controlled stage 2 hypertension in the absence of symptoms and end-organ damage.

Data regarding dietary changes in children with hypertension are limited. Nevertheless, the NHBPEP has taken an aggressive stance on sodium restriction, recommending sodium intake of 1,200 mg per day. A no-salt-added diet with more fresh fruits and vegetables combined with low-fat dairy and protein akin to the DASH (Dietary Approaches to Stop Hypertension) food plan may be successful in lowering blood pressure in children. Increased intake of potassium and calcium also has been suggested as nutritional strategies to lower blood pressure. Whatever lifestyle changes are recommended, a family-centered rather than patient-oriented approach usually is more effective.

Pharmacotherapy:

Reasons to initiate antihypertensive medication in children and adolescents include symptomatic hypertension, end-organ damage (e.g., LVH, retinopathy, proteinuria), secondary hypertension, stage 1 hypertension that does not respond to lifestyle changes and stage 2 hypertension. In the absence of end-organ damage or comorbid conditions, the goal is to reduce blood pressure to less than the 95th percentile for age, height, and sex. When end-organ damage or coexisting illness is present, a blood pressure goal of less than the 90th percentile is recommended. Drug therapy is always an adjunct to nonpharmacologic measures.

Information about long-term, untreated childhood hypertension and the impact of antihypertensive medications on growth and development is insubstantial. According to the NHBPEP, pharmacotherapy should follow a step-up plan, introducing one medication at a time at the lowest dose, and then increasing the dose until therapeutic effects are seen, side effects are seen, or the maximal dose is reached. Only then should a second agent, preferably one with a complementary mechanism of action, be initiated.[5]

Safe and effective use of antihypertensive agents requires adequate knowledge of their pharmacologic properties, including metabolism, disposition, and effect in children of varying ages[15].The choice of initial drug therapy is largely at the discretion of the physician. Diuretics and beta blockers have documented safety and effectiveness in children. Preferential use of specific classes of medications for certain underlying or coexisting pathology has led to the prescribing of ACE inhibitors in children .with diabetes or proteinuria and beta-adrenergic or calcium channel blockers for children with migraines. Becoming familiar with medications in each major class and with effective combinations of medications will facilitate treatment. Many medications have growing research to support their use. As with any chronic health issue, medical follow-up and appropriate monitoring are key to long-term success.[5]

Table-VII

Recommended initial doses for selected antjhypertensive agents for the management of hypertension in children and adolescents[11]

Class	Drug	Dose	Interval
Diuretics	Amiloride	0.4-0.6 mg/kg per day	q.d.
	Chlorthalidone	0.3 mg/kg per day	q.d.
	Furosemide	0.5-2. mg/kg per dose	q.d.-b.i.d.
	Hydrochlorothiazide	0.5-1 mg/kg per day	q.d.
	Spironolactone	1 mg/kg per day	q.d.-b.i.d.
Beta-adrenergic blockers	Atenolol	0.5-1 mg/kg per day	q.d.-b.i.d.
	Metoprolol	0.5-1 .0 mg/kg per day	q.d. (ER)
	Propranolol	1 mg/kg per day	b.i.d.-t.i.d.
Calcium channel blockers	Amlodipine	0.06-0.3mg/kg per day	q.d.
	Felodipine*	2.5mg per day	q.d.
	Nifedipine	0.25-0.5mg/kg per day	q.d.-b.i.d. (ER)
Angiotensin-convertmg	Captopril	0.3-0.5mg/kg per dose	b.i.d.-t.i.d.
enzyme inhibitors	Enalapril	0.08-0.6mg/kg per day	q.d.
	Fosinopril	0.1 -0.6 mg/kg per day	q.d.
	Lisinopril	0.08-0.6 mg/kg per day	q.d.
	Ramipril*	2.5- 6 mg per day	q.d.
Angiotensin-receptor	Candesartan	0.16-0.5mg/kg per day	q.d.
blockers	Irbesartan*	75-150mg per day	q.d.
	Losartan	0.75- 1.44 mg/kg per day	q.d.
	Valsartan	2 mg/kg per day	q.d.

q.d. once daily; b.i.d., twice daily; t.i.d., three times daily; ER, extended release. The maximum recommended adult dose should never be exceeded. *No dose **referenced to weight is available.**

Management of hypertensive crisis:

- Hypertensive crises occur as a result of an acute illness, such as postinfectious glomerulonephritis or acute renal failure, the excessive ingestion of drugs or psychogenic substances, or exacerbated moderate hypertension,
- The clinical manifestations may be those of cerebral edema, seizures, heart failure, pulmonary edema, or renal failure. Remember that accurately assessing BP in every patient presenting with a seizure is essential, particularly when no seizure disorder has been established in that patient.
- Anticonvulsant drugs are usually ineffective in treatment of a seizure due to a hypertensive crisis. However, seizures due to severe hypertension must be treated with a fast-acting antihypertensive drug.
- Drugs currently used to treat hypertensive emergencies include –

1. Labetalol, 0.2-1 mg/kg/dose up to 40 mg/dose as an intravenous (IV) bolus or 0.25-3 mg/kg/h i.v infusion
2. Nicardipine, 1-3 µg/kg/min i.v infusion
3. Sodium nitroprusside, 0.53-10 µg/kg/min i.v infusion to start[6]

- Hypertensive emergencies should be treated by an intravenous antihypertensive that can produce a controlled reduction in the blood pressure, aiming to decrease the mean arterial pressure by 25% over the first 8 hours after presentation and then gradually normalizing the BP over the next 48 hours[16]. Clinicians should be familiar with the effect and adverse effects of these drugs. Patients must be supervised closely to avoid an excessively rapid decrease in BP. which may result in underperfusion of vital organs.
- For the management of neonatal hypertension, treatment should be initiated in the presence of a

systolic blood pressure above the 99th percentile for age, or in the presence of end organ damage, the 95th percentile. Clear guidelines as to the definition of a hypertensive emergency in neonates is unclear, however if a recorded blood pressure is 30% greater than expected then emergency treatment should be initiated.[17]

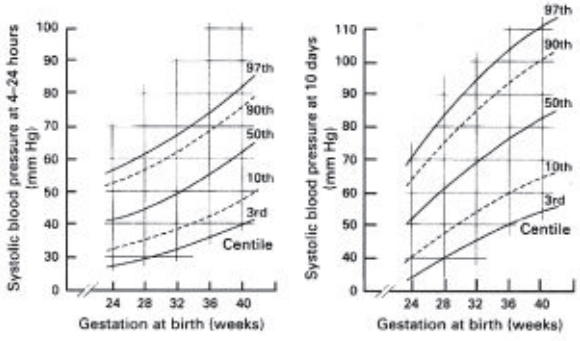

Fig.-I: *Reference Ranges Neonates*[17]

Transcatheter theory

- Interventional cardiac catheterization procedures can be used to treat coarctation of the aorta. Balloon dilation of a previously untreated coarctation remains controversial. Some pediatric cardiologists recommend this approach and also place a stent at the coarctation site. The appropriateness of this approach remains to be determined in studies of long-term outcome.
- Balloon dilation, with or without stent placement, has gained widening acceptance for treatment of recurrent coarctation. Recurrence is most likely to arise when young infants must undergo surgical repair because of the severity of the lesion.
- Interventional catheterization with balloon dilation can also successfully relieve many instances of discrete renal artery stenosis.

Surgical Care:

Surgery may be required for children with severe renal vascular hypertension, renal hypoplasia, coarctation of the aorta, Wilm's tumor, or pheochromocytoma.[6]

Follow Up:

Close monitoring of patients with hypertension, particularly during the initial phase of therapy is needed. A chemistry panel should be checked after therapy with an ACE inhibitor or an angiotensin-II receptor blockers (ARBs) is started or increased. The frequency of visits is dictated by various factors, including the following:

- Degree of control
- Extent of understanding of the disease and its treatment by both the parents and/or caregivers and the patient
- Adherence to nonpharmacologic and pharmacologic treatments
- Ability to properly monitor blood pressure (BP) at home
- Likelihood of drug adverse effects
- Need to monitor for complications of hypertension
- Need to monitor for weight loss.

After surgical or catheter treatment of coarctation of the aorta, patients must be monitored yearly with accurate measurement of systolic and diastolic pressures in the right arm. For these measurements, the patient should be properly positioned. Systolic pressures in both the right arm and leg should be obtained with the patient supine. Remember that systolic pressure in the lower leg should exceed that in the arm.[6]

References

1. Villar VA, Liu T, Jose PA, Recent trends in pediatric hypertension research. J Med Liban 2010; 58(3) : 179-87.
2. Seikaly MG, Bahlawan-Seikaly S, Strategies of treatment of pediatric hypertension, J Med Liban 2010; 58(3) : 161-66.
3. Sanjad SA, Etiology of hypertension in children and adolescents, J Med Liban 2010; 58(3) : 142-5.
4. http://highbloodpressure.about.com/od/lifeafterdiagnosis/tp/Hypertension-Risks-in-Children.htm
5. Gregory B. Luma, Roseann T. Spiotta, Hypertension in Children and Adolescents, Am Fam Physician, 2006; 73(9) : 1558-68.
6. http://emedicine.medscape.com/article/889877 - overview (1/5/2011, at 9:28am)
7. Ilyas M, Ellis EN, Management of childhood hypertension: a guide for primary care physicians. J Ark Med Soc, 2006; 103(6): 137-40.
8. McCrindle BW. Assessment and management of hypertension in children and adolescents. Nat Rev Cardiol, 2010; 7(3):155-63.

9. Sinha Manish D, Reid Christopher J.D. Evaluation of Blood Pressure in Children, Current Opinion in Nephrology and Hypertension 2007; 16(6):577-84.

10. Joseph T. Flynn. Pediatric Hypertension: Recent Trends and Accomplishments, Future Challenges. American Journal of Hypertension 2008 21(6) 605-12.

11. Empar Lurbe, Renata C, J. Kennedy C, Michael J. D et al. Management of high blood pressure in children and adolescents: recommendations of the European Society of Hypertension, Journal of Hypertension 2009; 27:1719-42.

12. Kavey RW, Kveselis DA, Atallah N, Smith FC. White Coat Hypertension in Childhood: Evidence for End-Organ Effect, *J Pediatr* ; 2007;150:491-97.

13. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents. National Heart, Lung and Blood Institute, Bethesda, Maryland, Pediatric 2004; 114:555-76.

14. Fernandes E, McCrindle BW. Diagnosis and treatment of hypertension in children and adolescents. Can J Cardiol. 2000; 16(6): 801-11.

15. Douglas L. Blowey. Antihypertensive agents: mechanism of action, safety profiles, and current uses in children. Current Therapeutic Research. 2001; 62(4): 298-313.

16. http://www.pedheartsat.org/articles/Acute%20Hypertension%20and%20Hyp ertensive%20Crisis% 20in%20Children.html

17. Dr J Beattie. Renal Clinicians Group, Q-Pulse ref: YOR-REN-022; 2007: 13.