REVIEW ARTICLE

Pediatric Hypertension: Current Strategies and Clinical Management

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Summary:

Hypertension is a common disease. Prevalence of hypertension appears to be increasing in school-aged children. Many hypertensive children are unaware of such condition. Morbidity and mortality of hypertension cannot be ignored. Proper diagnosis and treatment is essential to overcome hypertension related complications. Treatment depends on type and stage of hypertension, associated co-morbid condition, underlying etiology and on some other factors. Initial management of essential hypertension generally comprises life style modifications and most children with sustained secondary hypertension require anti-hypertensive agents. The objective of treatment of hypertension without hypertensive target-organ damage is to maintain BP <95th percentile for the child. Commonly used medications in children include angiotensin converting enzyme inhibitors, calcium channel blockers, vasodilators, â blockers and thiazide diuretics. Therapy is started generally with one agent and the highest recommended dose is achieved. A drug from a different class is added or substituted if the highest dose is ineffective. More frequent adjustment of medications is to be avoided. Blood pressure is monitored properly. Some patients require life-long therapy whereas others may require a gradual reduction of drug after satisfactory control of BP over a period. Therapy may be discontinued carefully if the underlying cause is corrected. Surgical intervention may be needed in certain cases in children.

Key words: Hypertension, management, children, anti-hypertensive drug.

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Introduction:

Hypertension is one of the commonest diseases with an estimated worldwide prevalence of 1 billion. Prevalence of this condition in children is reported to be 1-3%. In school-aged children, prevalence appears to be increasing, perhaps due to increased prevalence of childhood obesity[1]. Study revels that 4.5% school going children suffers from hypertension[2]. Prevalence of persistent secondary hypertension in children is 0.1%[3]. Even in United States, one-third of people are unaware of this problem and another one-third has blood pressure control below establish goals[4]. Morbidity and mortality of hypertension cannot be ignored. Each increment of 20 mmHg in systolic or 10 mmHg in diastolic pressure doubles the risk of cardiovascular diseases[5]. Children and adolescents with severe elevation of BP are at increased risk of adverse outcomes, including hypertensive encephalopathy, seizures, and even cerebrovascular accidents and congestive heart failure[6,7]. Even hypertension that is less severe contributes to target-organ damage when it occurs with other chronic conditions such as chronic kidney disease[8]. Proper diagnosis and timely institution of appropriate therapy is essential to overcome hypertension related morbidity and mortality in children. Unfortunately many often this important issue is ignored in pediatric population. Clinician is to be updated enough regarding proper management of hypertension in children. The review is written to orient health personals specially the clinicians regarding such fundamental issue of blood pressure with a view to minimize hypertension related morbidity and mortality in children through its management appropriately.

Case definitions of hypertension:

Definition of hypertension ideally is based on a threshold level of blood pressure that divides those at risk for adverse outcomes from those who have no increased

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risk. The American Academy of Pediatrics defines hypertension as[9]: Average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) that is ≥95th percentile for gender, age, and height on 3 occasions. Prehypertension in children is defined as average SBP or DBP levels that are 90th percentile but <95th percentile. As with adults, adolescents with BP levels 120/80 mm Hg should be considered prehypertensive. If the BP is >90th percentile, the BP should be repeated twice at the same office visit, and an average SBP and DBP should be used. If the BP is >95th percentile, BP should be staged. Staging of BP is helpful for planning of evaluation and treatment of hypertension. Stage-1 hypertension is the designation for BP levels that range from the 95th percentile to 5 mmHg above the 99th percentile. Stage-2 hypertension is the designation for BP levels that are >5 mmHg above the 99th percentile. The difference between the 95th and 99th percentiles is only 7 to 10 mm Hg. Hypertensive emergencies are defined as the presence of severe hypertension associated with life-threatening complications including encephalopathy, acute heart failure, pulmonary edema, dissecting aortic aneurysm or acute renal failure and need urgent control of BP. Hypertensive urgencies are situations where chance of immediate complications is less but prompt institution of drug therapy and reduction of blood pressure over 24 hours is appropriate.

Evaluation of hypertension:

Evaluation of Blood pressure is prerequisite for its proper management. Blood pressure should be measured annually in all children more than 3 years old, who are seen in health center. Blood pressure should also be measured in all at-risk younger children with (i) history of prematurity, very low birth weight or intervention in intensive care unite. (ii) congenital heart diseases. (iii) recurrent urinary tract infection, known renal or urological diseases. (iv) family history of congenital renal disorders, malignancy or post organ transplant (vi) conditions associated with hypertension e.g. neurofibromatosis, tuberous sclerosis or ambiguous genitalia. Blood pressure should be measured in children who present with features of kidney disease, seizure, altered sensorium, headache or visual complaints[10].

Careful history and physical examination provide clues to the underlying etiology. History regarding dietary habits, physical activity is important. History of umbilical catheterization and oligohydramnios is looked for[10]. It is important to inquire about use of drugs because some drugs may increase blood pressure. Because of presence of associations of hypertension with sleep disorders, particularly among overweight children, a history of sleeping pattern should be obtained[9]. Past history of hospitalizations, trauma, urinary tract infections may uncover definable causes of hypertension. Family history addressing diabetes, dyslipidemia, obesity, cardiovascular or cerebrovascular disease and renal disorders should search. Symptoms of renal, cardiac and thyroid disorders are emphasized[10]. During examination, patient's weight, height and body mass index (BMI) is calculated. Peripheral pulses should be palpated. Blood pressure should be measured properly in both arms and at least in one lower limb. Pressure in lower limbs normally exceeds that in upper limbs by 10-20 mmHg[10]. If blood pressure in leg is lower than arm BP or if femoral pulses are weak or absent, coarctation of the aorta may be suspected[9]. The remaining physical examination should pursue clues found on history and should focus on cause and severity of hypertension. The extent of hypertension depends on the patient's age, severity and duration of hyprtension, presence of target organ damage or underlying disorders[10]. The laboratory evaluation is based on the child's age, history, physical examination findings and level of BP elevation. Majority of children with secondary hypertension will have renal or renovascular causes[9] and screening tests are designed to giving preference of such cause. Initial laboratory workups are needed in majority of hypertensive cases and additional tests are only needed in specific cases (Information box-1).

Initial evaluation- A pediatrician should perform this basic workup. A through personal and family history, physical examination is followed by urine dipstick examination and baseline chemistry (information box-1). An abdominal ultrasound is a useful screening test which evaluates the sizes of kidneys, adrenal tumors and is a valuable diagnostic test for cystic renal diseases, renal calculi, dilation of collecting system or of duplex system, ureterocele and thickened bladder wall[1]. *Additional evaluation*-All children with hypertension need a diagnosis of exclusion. Children with history of UTI should undergo a $99T_c$-dimercaptosuccinic acid static scan. This is more sensitive than conventional intravenous urography, requires less exposure to

Information Box-I

Laboratory investigations of child with hypertension

Level-I (Initial evaluation/basic diagnostic workup):

i). Full blood count. ii) Blood urea, creatinine, serum electrolytes iii) Blood glucose, lipid propfile, uric acid.

iv) Urinalysis, culture v) X-Ray chest. vi) 24 hours urinary protein or protein to creatinine ratio vii) Renal ultrasound. viii) Electrocardiography.

ix)Screening for target organ damage (e.g. echocardiography etc).

Level-II (Additional diagnostic test for sustained hypertension):

Glomerulonephritis->Compliment C_3, Ant-nuclear antibody, anti-dsDNA, renal biopsy.

Reflux nephropathy->Micturating cystourethrogram, DMSA scintigraphy, DTPA scan.

Renovascular hypertension->Doppler flow study, captopril renography, MRI, CT scan.

Coarctation of aorta-> Angiography.

Endocrine causes ->SerumT_4, TSH, plasma rennin activity, aldosterone level, plasma and urinary cortisol, plasma and urinary catecholamines.

radiation and is considered the gold standard for diagnosis of renal scarring. Frusemide DTPA scan is helpful when an obstructive uropathy is suspected. An MCU is recommended in children under 2 years of age with history of UTI for diagnosis and staging of vasicoureteric reflux and for further management[1]. Other additional investigation is designed on the basis of underlying cause of hypertension.

Treatment of hypertension:

Treatment of hypertension should be judicious. During treatment, type and stage of hypertension, associated co-morbid condition and underlying cause of hypertension should be considered. Other factors like age of patient, drug availability, drug cost, untoward effect of drug is to be addressed. Clinician should recall some basic questions in treating hypertension e.g. (i) who is to be treated? (ii) When is to be treated? (iii)why is to be treated? (iv) How is to be treated and (v) Where is to be treated? Answers of these questions may be searched in succeeding discussions.

While the initial management for patients with essential hyper-tension comprises life style modifications, most patients with sustained secondary hypertension require treatment with anti-hypertensive agents[9,10]. The objective of treatment of hypertension in case of primary hypertension without hypertensive target-organ damage, is to maintain BP <95th percentile for age, sex and height, whereas for children with chronic renal disease, diabetes, or hypertensive target-organ damage, BP should maintain <90th percentile for age, sex and height[9].

Pre-hypertension: Patients with pre-hypertension are primarily managed by lifestyle modifications and revaluated 6 months later. The parents of these children are informed and advised regarding careful follow up. Medications are not required unless the patient has comorbid conditions (*e.g*., chronic kidney disease, diabetes mellitus or dyslipidemia) or evidence of target organ damage[10].

Essential hypertension: Patients with essential hypertension are initially managed with lifestyle modifications. Pharmaco-logical therapy is initiated if there is (i) a comorbid condition (chronic kidney disease, diabetes mellitus or dyslipidemia), (*ii*) target organ damage or (*iii*) failure of blood pressure to decline below the 95th percentile, despite lifestyle modifications for 6 months.

Lifestyle modifications: Lifestyle changes are recommended for all children with hypertension; interventions based on daily routines are likely to be more successful.*(i)Weight reduction:* Weight loss in overweight adolescents is associated with a decrease in BP[11,12]. Blood pressure levels track from childhood through adolescence and into adulthood in association with weight. Because of the strong correlation between weight and BP, excessive weight gain is likely to be

associated with elevated BP over time. Therefore, maintenance of normal weight gain in childhood should lead to less hypertension in adulthood[9]. Weight control not only decreases BP, it also decreases BP sensitivity to salt[12] and decreases other cardiovascular risk factors such as dyslipidemia and insulin resistance[9]. With a reduction in BMI of 10% a short-term reduction of 8 to 12 mm Hg in BP were observed[9,10]. Weight control can render pharmacologic treatment unnecessary but should not delay drug use when indicated[9]. Weight reduction should be achieved by regular physical activity and diet modification. Prevention of excess weight gain limits future increase in blood pressure[10].

(ii)Increased physical activity: Children are encouraged to be active not only for weight control but for their well being. They are likely to continue activities incorporated into their routines, *e.g*., walking or cycling to school, playing with friends outdoors and swimming[10]. Regular physical activity and restriction of sedentary activity will improve efforts at weight management and may prevent an excess increase in BP over time[9]. A daily physical activity of 30-60 minutes or more involving a variety of activities is developmentally appropriate and enjoyable[13]. Adolescent girls in country like our, should be specifically targeted since they spend considerably less time than boys in outdoor sport. Participation in competitive sports is avoided in patients with stage 2 hypertension or target organ damage, until blood pressure is controlled satisfactorily. Heavy exercises like weight lifting, gymnastics, karate and judo should be avoided[10].

(iii)Dietary changes: Direct evidence on the benefits of dietary changes from vigorous, well-controlled trials in children and adolescents is sparse.However, dietary modification should be strongly encouraged in children and adolescents who have BP levels in the prehypertensive range as well as those with hypertension[9]. Recommendations for daily sodium intake in children range between 1-1.5 g (45-65 mEq Na, 2.6-3.8 g salt). Dietary sodium restriction is associated with small reductions in blood pressure in children[10,14]. A 'no added salt diet' is a satisfactory approach to restrict salt intake. Intake of food products high in sodium (processed and canned foods, 'fast foods' eg. pizzas, pickles and salted potato chips etc.) should be avoided[14]. Fried foods, snacks and sweet dishes should be limited[10].

Increased potassium intake, through vegetables and fruits, is associated with modest reduction of systolic and diastolic blood pressure in adults with essential hyper-tension[14]. Potassium intake should be restricted in children with chronic kidney disease with glomerular filtration rate less than 30 ml/min/1.73 m^2, adrenal insufficiency, severe heart failure, or those who are treating with angiotensin converting enzyme inhibitors (ACEI), non-steroidal anti-inflammmatory drugs and potassium sparing diuretics. Despite suggestions that foods rich in calcium, magnesium, folic acid and fiber are useful in reducing blood pressure, there is limited evidence in this regard[9,10].

An increased intake of fresh vegetables and fruits, whole grains and non-fat dairy is recommended. These foods are low in sodium and saturated fat and rich in minerals (potassium, calcium, magnesium) and fiber. A daily food consisting of half (50%) vegetables and/or salads and fruits, a quarter (25%) cereals (rice and/or chapattis), and the remainder protein based (legumes, milk, egg, animal protein) is recommended[10].

Secondary hypertension: Patients with sustained secondary hypertension require therapy with antihypertensive agents. Physicians should be aware of risk of hypertensive emergencies in children with stage 2 hypertension. The need of healthy eating habits and lifestyle is also emphasized.

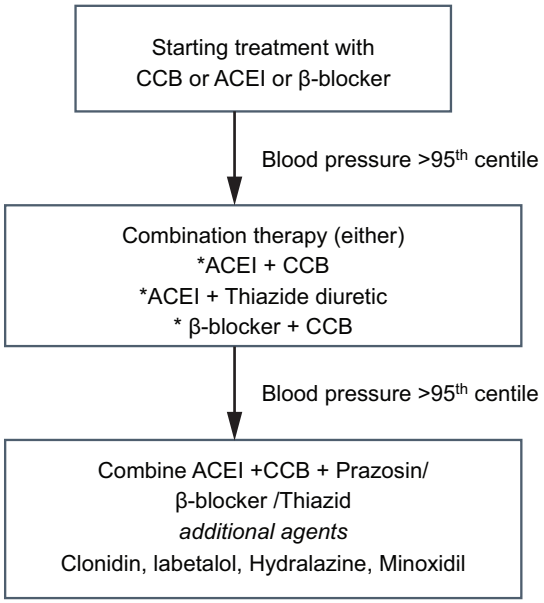
***Drug therapy*:** Drug therapy is indicated in patients with (*i*) acute or chronic complications of hypertension, including evidence of target organ damage, (*ii*) secondary hypertension, (*iii*) stage 2 hypertension, (*iv*) stage 1 hypertension that persists despite 6-months' of lifestyle modifications, and (*v*) pre-hypertension or stage 1 hypertension with comorbid conditions like diabetes, chronic kidney disease or dyslipidemia.

Principles of treatment: The basic principles for treating hypertension are as follows[10]: *The goal for treatment is reduction of blood pressure to levels <95th percentile, unless comorbid conditions or target-organ damage is present, when it should be lowered to <90th percentile.*Commonly used medications in children include ACEI, calcium channel blockers (CCB), vasodilators, â blockers and thiazide diuretics.* Therapy is started with an appropriate dose of one agent and the highest recommended dose is achieved to control BP. A drug from a different class is added or substituted if the highest dose is ineffective.* Medications with a longer duration of action eg. Once or twice daily dosing is preferred.* Dose adjustment of antihypertensive medications need not be made more frequently than every 2-3 days.

Nifedipine and amlodipine are effective CCB for children. The availability of long acting preparations permits once

or twice daily dosing. Sustained release preparations of nifedipine should be swallowed whole, and not crushed or chewed. Captopril, chiefly used in young infants, requires dosing every 6-8 hrs. Beyond infancy, enalapril (1-2 daily doses) is preferred. Newer ACEI (lisinopril, ramipril) require once daily dosing and have fewer side effects. Angiotensin receptor blockers used in children include losartan, valsartan and irbesartan. Cardioselective b-blockers (atenolol, metoprolol) are effective agents, requiring once or twice daily dosing and have few side effects. The use of propranolol is limited in view of the need for multiple daily doses and side effects. Labetalol is useful in patients refractory to other medications[10].

Combinations minimize the side effects by allowing administration of lower dosage of different agents. With combination therapy, consideration must be given to combining drugs with complementary mechanism of action, *e.g.*, ACEI (or angiotensin receptor blocker) with a CCB or thiazide diuretic, or vasodilator with diuretic or b blocker (*Fig. 1*). While combinations of ACEI and angiotensin receptor blocker have been proposed for adults, similar experience is limited in children[15]. Long term combination of thiazides with b-blockers may be associated with an increased incidence of glucose intolerance[16].



Treatment may be started with Calcium channel blocker (CCB) or angiotensin converting enzyme inhibitor (ACEI) or β-blocker. Combination therapy with two drugs is initiated if BP is not controlled. Unsatisfactory control of blood pressure requires combination therapy with more drugs.

Figure-1: *Flow chart of treatment scheme of hypertension in children*

***Specific recommendations*:** The choice of medication also depends on the cause of hypertension and associated complications.

(i)Essential hypertension: While there is no consensus on the appropriate initial therapy, the choices are between CCB and ACEI. Therapy with b-blockers is recommended in patients who cannot tolerate ACEI or CCB[15].

(ii)Acute glomerulonephritis: Hypertension in post-infectious glomerulonephritis is of short duration and associated with salt and water retention. Fluid and sodium restriction and judicious use of loop diuretics are useful in patients with circulatory congestion, hypertension and edema. Severe hypertension with or without encephalopathy is an emergency and usually responds to treatment with CCB and furosemide. Occasionally treatment with a b-blocker or ACEI may be necessary[10].

(iii)Chronic kidney disease: The target blood pressure in these patients is <90th percentile. For patients with chronic kidney disease stage I-III (GFR >30 mL/min/1.73 m^2) therapy should be initiated with ACEI, since these agents also reduce proteinuria and retard progression of renal damage[17]. The dose of ACEI (or angiotensin receptor blockers) is reduced if serum creatinine exceeds 30-35% from the baseline or there is hyperkalemia. Treatment with ACEI should be avoided in patients with advanced chronic kidney diseas. Therapy in these cases is initiated with either a CCB or b-blocker[10].

Guidelines for managing hypertension in patients with chronic kidney disease also include:*Sodium intake is restricted to between 1-1.5 gm (2.6-3.8 gm salt).*Co-administration of diuretics helps in reducing sodium and volume overload. Thiazides are satisfactory, but not effective at GFR <30 mL/min/1.73 m^2.*Additional medications include a-blockers, centrally acting agents or vasodilators.* The dosage of some medications (*e.g.*, atenolol) need modification in renal impairment (*Table-I*)[10].

(iv)Renovascular disease: In this condition therapy should be initiated with a CCB or/and a b-blocker. Additional agents include prazosin, labetalol, clonidine, hydralazine and/or minoxidil. While therapy with ACEI or angiotensin receptor blockers is avoided in patients with suspected or confirmed bilateral renovascular

disease, these agents might be used cautiously in those with unilateral renovascular hypertension[10]

Hypertensive emergencies: Patients with stage 2 hypertension may present with acute, life threatening target organ damage involving central nervous system (encephalopathy, seizures), heart (pulmonary edema) or kidneys (acute renal failure). These patients need hospitalization for monitoring and supportive care. Blood pressure levels are usually 5-15 mm above the 99th percentile, and should be reduced to safe levels. Rapid reduction of blood pressure might, however, compromise blood flow and result in ischemic complications in the brain, retina, spinal cord and kidneys. Blood pressure reduction, therefore, must be regulated in order to prevent end organ damage to these organs[18].

The difference between the observed and desired (95th percentile) blood pressure is estimated; Hypertensive emergencies should be treated by an intravenous antihypertensive drug aiming to desired reduction of 25% over the first 8 hours after presentation and then gradually desired normal level over 26 to 48 hours[19,20]. Agents of choice include short acting, intravenous preparations (IV) that are titrated to response (sodium nitroprusside, nitroglycerine, labetalol and nicardipine) (*Table-I*). Therapy with enteral antihypertensive drugs should be instituted within 6-12 hr of parenteral therapy, and the latter gradually withdrawn over the next 12-24 hr[10]. In this case, Sodium nitroprusside can be used in most hospital settings. Initially infused at a rate of 0.3-0.8 mg/kg per minute, the dose may be increased in increments of 0.1-0.2 mg/kg per minute, every 15 minutes, if the desired reduction is not achieved. Blood pressure is measured at least every 15 minutes; pupillary reflexes, visual acuity and level of consciousness are also monitored. Two IV lines, one for drug infusion and the other for saline infusion should be maintained remembering chance of precipitous fall of BP. Loss of pupillary reflex to light is an early indicator of retinal vascular ischemia, requiring immediate infusion of normal saline[10].

Immediate releasing sublingual nifedipine can be used effectively in pediatric patients for hypertensive emergencies because of rare chance of arrhythmias, syncope, cerebrovascular accidents and myocardial infarction of this agent in children[21]. The risk of sudden fall of blood pressure is limited, particularly if the dose of nifedipine is between 0.1-0.25 mg/kg[22]. Physicians should be aware of requiring more than one dose[10]and about additional longer-acting medications[23]. Volume depletion is common in patients with severe hypertension and IV administration of loop diuretic together with a potent anti-hypertensive agent might lead to a precipitous drop in blood pressure. Diuretics should therefore be avoided unless specifically indicated for volume over-load as occurs in glomerulonephritis coexisting pulmonary edema[10].

Hypertensive urgencies: Hypertensive urgencies differ from emergencies in having no evidence of acute target organ damage. Patients have stage-2 hypertension and symptoms like headache and/or vomiting but are at risk for progression to hypertensive emergencies. Controlled reduction of blood pressure, using oral medications, over several hours is desirable. Effective oral agents include nifedipine, clonidine and labetalol[9.10].

The onset of action of nifedipine administered orally is within 5-10 min, peaks at 30-60 min and lasts for 2-6 hr. While children show reflex tachycardia, the occurrence of serious complications with the use of oral nifedipine in this situation is rare. Oral administration of clonidine is also effective, although the onset of action (30-60 min) and peak effect (2-4 hr) is delayed. Sublingual or oral administration of captopril also shows a rapid onset (10-30 min) and peak (1-2 hr), and relatively prolonged duration of action (4-8 hrs). Despite overall efficacy of the above agents, a predictable reduction of blood pressure is often not possible. Patients with hypertensive urgencies should be observed closely, since use of IV medications might be required[10].

Neonatal hypertension: Blood pressure in neonates is determined by birth weight and gestational age. Renovascular (renal artery or venous thrombosis) and renal parenchymal disorders are important causes of hypertension. Newborn with severe hypertension is managed with continuous IV infusion of nitroprusside or labetalol. Effective oral agents include CCB, hydralazine and minoxidil; ACEI should be administered at lower doses[10].

Oral antihypertensive agents may be considered when the hypertension is less severe or when the infant is ready to be weaned from intravenous therapy. Captopril has proven to be effective. When captopril alone is not

Table-I

Oral Antihypertensive Medications

Agents	Dose; frequency	Comments
Angiotensin converting enzyme inhibitors, angiotensin receptor blockers		
Captopril	0.3 - 6 mg/kg/day; tid	Use should be cautious if GFR <30 ml/min/1.73 m^2; avoidance is wise in renal artery stenosis. In neonates, smaller doses are to be prescribed. Serum potassium and creatinine should be monitored regularly Side effects include hyperkalemia, impaired renal functions, anemia, neutropenia and infrequent dry cough.
Enalapril	0.1 - 0.6 mg/kg/day; qd	
Lisinopril	0.06 - 0.6 mg/kg/day; qd	
Ramipril	6 mg/m^2; qd	
Irbesartan	4-5 mg/kg/day	
Losartan	0.7 - 1.4 mg/kg/day; qd	
Calcium channel blockers		
Amlodepine	0.05 - 0.5 mg/kg/day; qd-bid	Extended release nifedepine must be swallowed whole. Side effects: Headache, flushing, dizziness, tachycardia. At higher doses: leg edema and erythema may occur.
Nifedipine (extended release)	0.25 - 3 mg/kg/day; qd-bid	
Isradipine	0.15 - 0.8 mg/kg/day; tid	
Beta-blockers		
Atenolol	0.5 - 2 mg/kg/day; qd-bid	Atenolol: If GFR <50 ml/min/1.73 m^2 dose should be decreased by 50%; At GFR <10 ml/min/1.73 m^2 dosing should be on alternate days.
Metoprolol	1 - 6 mg/kg/day; bid	
Propanolol	1 - 4 mg/kg/day; tid	Sleep disturbances with propranolol, metoprolol; hyperlipidemia may occur.
Labetalol	1 - 40 mg/kg/day; bid-tid	Avoidance is necessary in asthma, heart failure; symptoms of hypoglycemia may be observed.
Central alpha agonist		
Clonidine	5 - 25 mg/kg/day; tid-qid	Abrupt cessation may cause rebound hypertension; sedation
Peripheral alpha antagonist		
Prazosin	0.05 - 0.5 mg/kg/day; bid-tid	May cause 'first dose' hypotension and syncope.
Vasodilators		
Hydralazine	1 - 8 mg/kg/day; qid	For hypertension refractory to other drugs this group is helpful.
Minoxidil	0.1 - 1 mg/kg/day; qd-bid	Side effects: headache, palpitation, fluid retention, congestive heart failure; pericardial effusions, hypertrichosis with minoxidil.
Diuretics		
Frusemide	0.5 - 6 mg/kg/day; qd-bid	Periodic monitoring of electrolytes and fluid status is needed.
Spironolactone*	1 - 3 mg/kg/day; qd-bid	Side effects of Thiazides include dyslipidemia, hyperglycemia, hyperuricemia, hypokalemia and hypomagnesemia.
Metolazone	0.2 - 0.4 mg/kg/day; qd	Side effects of loop diuretics include metabolic alkalosis, hypokalemia and hypercalciuria.
Hydrochlorothiazide	1 - 3 mg/kg/day; qd	
Amiloride*	0.4 - 0.6 mg/kg/day; qd	*Use with ACEI, angiotensin receptor blockers should be cautious.

qd once daily; bid twice daily; tid thrice daily; qid four times daily

effective, addition of a diuretic often yields the desired blood pressure reduction particularly in infants who have chronic lung disease. Beta-blockers should be avoided in such condition[24].

Surgical treatment:

Surgery may be needed in certain cases in correcting or controlling hypertension in children.Correction of renal artery stenosis by balloon angioplasty or operative bypass procedures is needed[25]. Partial or complete nephrectomy can be considered in cases of segmental renal infarct, unilateral renal hypoplasia with diminished function, or chronic obstruction. To maximize the potential for complete resolution of hypertension, the affected and contralateral kidney should be evaluated carefully, including assessment of renal vein renin prior to surgery. The other major role for surgical intervention is in cases of pheochromocytoma[1,10].

Monitoring of Hypertensive Children:

Appropriate duration of treatment for a child or adolescent is unknown. Some patients require lifelong therapy; others may experience improvement or even resolution of hypertension. Overweight children with uncomplicated essential hypertension, who successfully lose weight, are best candidates for "step-down" treatment. This approach attempts a gradual reduction of medication after 8-12 months of satisfactory blood pressure control[10] and discontinued under careful observation if the underlying cause is corrected[1].Counseling of family members and patient regarding natural history of hypertension, necessity of proper controling blood pressure along with emphasis on lifestyle modifications is needed. Blood pressure is monitored every 3 months generally. Screening for end organ damage, renal dysfunction and surveillance for side effects of drugs is required annually[10].

Conclusions:

Measurement of blood pressure is an important component of pediatric physical examination that enables screening of hypertension. Elevated blood pressure in children may be a sign of an underlying disease or represent early onset essential hypertension. Patients with pre-hypertension are primarily managed by lifestyle modifications. Though essential hypertension is predominantly observed in adult patient, its presence in children can not be ignored. Essential hypertension is initially managed with lifestyle modifications. Weight reduction, increasing physical activities and diatary modifications are the main streems of lifestyle modifications. Pharmacological therapy is initiated if there is comorbid condition or target organ damage or failure of blood pressure to decline below 95th percentile despite 6 months lifestyle modifications. Secondary hypertension needs drug therapy. Commonly using drugs in children include ACEI, calcium channel blockers, vasodilators, b-blockers and thiazide diuretics. Therapy is started with an appropriate dose of one agent and the highest recommended dose is achieved to controle BP. A drug from a different class is added or substituted if the highest dose is ineffective. Dose adjustment of antihypertensive medications need not be made more frequently than every 2-3 days. Gradual reduction of medication may be done after 8-12 months of satisfactory blood pressure control.Children with hypertension need appropriate treatment, proper counseling and long term follow up, which can be done satisfactorily by pediatricians.

Conflict of interest: None

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