

Management of High Blood Pressure in Pediatrics

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Abstract: *Background:* The diagnosis of systemic hypertension is missed in the majority of cases as familiarity with pediatric hypertension among clinicians is poor so it is usually a silent killer. We aimed to evaluate the management lines for systemic hypertension of children attended to ASSIUT university childrens hospital with systemic hypertension. *Patients and methods:* it is a prospective study that included all cases with systemic hypertension admitted to Assiut university childrens` hospital from 1st July 2015 to - 31 January 2016. Patients were evaluated for detection of the causes of secondary hypertension, associated comorbidities including fasting lipid panel and fasting serum glucose level .and for target organ damage including retinopathy ,nephropathy, left ventricular hypertrophy, and neuropathy. They were also evaluated for blood pressure control using pharmacological and non pharmacological lines . *Results:* we found that all patients were treated with antihypertensive drugs , 72% of patients were on polytherapy while the rest of patients were on monotherapy. Blood pressure was controlled in all patients on monotherapy but controlled only in 73% of patients on polytherapy. *Conclusion:* The causes of resistant hypertension in uncontrolled patients mostly due to renal causes such as chronic renal failure and nephritic syndrome and rapid progressive glomerulonephritis

Keywords: Systemic hypertension , ,renovascular hypertension , management, pediatrics

1. Introduction

In 2004, the National High Blood Pressure Education Program published its fourth report on hypertension in children with definitions of pediatric hypertension [1]. This report defines hypertension as over 90th BP according to age, sex, and height [1].so that pre hypertension (BP between the 90th and 95th percentile) ,Stage 1 HTN is defined as having three or more BPs at or above the 95th percentile but <99th percentile +5 mmHG,Stage 2 HTN is defined as having three or more BPs at or above the 99th percentile + 5mmHG.

Hypertension can be categorized as primary or secondary. Primary hypertension does not have an etiology, but rather is related to genetics and lifestyle .Secondary hypertension, , is caused by renal diseases, pulmonary diseases, and medications., Secondary hypertension is much more common than primary ,especially among adolescents.{2} For office BP measurement in children, the use of a mercury sphygmomanometer and the auscultatory method are recommended or, if not available, by oscillometric devices . By convention, an appropriate cuff size is a cuff 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 (3) . With a standard clinical sphygmomanometer, using a stethoscope placed over the brachial artery pulse, proximal and medial to the cubital fossa, and below the bottom edge of the cuff , about 2 cm above the cubital fossa. The use of the bell of the stethoscope may allow softer Korotkoff sounds to be heard better (4)

Hypertension is rarely accompanied by any symptoms, and its identification is usually through screening, or when seeking healthcare for an unrelated problem. Some with high blood pressure report headaches, vertigo, tinnitus , altered vision or fainting episodes (5). The presence of any comorbidity such as obesity ,diabetes mellitus and hyperlipidemia carries the potential to increase the risk for

cardiovascular disease and can have an adverse effect on health outcome.

The goals of evaluation are: to identify target-organ damage such as neuropathy, nephropathy, retinopathy , left ventricular hypertrophy and to identify secondary hypertension when suspected. . Regarding management the hypertensive patient may be 1-unstable either a-hypertensive emergency; blood pressure greater than the 99th percentile with end-organ changes (such as 1) seizures 2) encephalopathy; 3) severe headache with vomiting 4) cerebral infarction or hemorrhage; 5) congestive heart failure; or 6) hypertensive renal failure. b-hypertensive urgency; blood pressure greater than the 99th percentile without end-organ changes . 2-stable and managed with pharmacological and non pharmacological lines as weight reduction ,limiting salt and cholesterol intake . The pharmacological lines may be mono-therapy or poly-therapy .Consideration should be given to combining drugs with complementary mechanisms of action, such as an angiotensin converting enzyme inhibitor with a diuretic, or a vasodilator with a diuretic or beta-adrenergic blocker. For children with uncomplicated primary hypertension and no hypertensive target-organ damage, the goal blood pressure should be less than the 95th percentile for sex, age, and height otherwise the goal is 90th percentile

This study aimed to

- 1) To assess how much the adopted protocols of management of systemic hypertension is applied in Assiut university childrens` hospital.
- 2) To know the latest scientific evidence regarding blood pressure in children and to provide recommendations for diagnosis, evaluation, treatment and outcome of hypertension

2. Patients and Methods:

This prospective study was conducted at ASSIUT university children hospital between July 2015 and January 2016.. The study included 47 patients with systemic hypertension.

Their ages ranged from 1-17 years mean \pm SD = 11.77 \pm 3.96 , where 53.19% of cases were males and 46.8% of cases were females

The causes of systemic hypertension were due to renal diseases (85.1%), cardiovascular diseases (4.3%), idiopathic hypertension (2.1%), systemic lupus erythematosus and drug induced hypertension .(8.5%) . Detailed history was taken from the parents asking about present history to detect causes of secondary hypertension as (cardiac ,renal, endocrinal causes) family history of (renal disease or hypertension ,therapeutic history) . Besides the detailed history all patients were examined accurately generally and systemically.

The following investigations were performed :blood urea nitrogen, creatinine, electrolytes, urinalysis,, urine culture,

complete blood count , renal ultrasound , plasma and urine steroid levels, plasma and urine catecholamines to detect causes of hypertension. .Also fasting lipid profile and glucose level were evaluated to detect associated comorbidities such as hyperlipidemia and diabetes mellitus. Associated target organ damage such as retinopathy and left ventricular hypertrophy was detected by echocardiography and fundus examination.

All children with primary and secondary hypertension whose blood pressure > 95% percentile (stage 1, 2) were included in the study, children were excluded if their blood pressure percentile < 95%.

The definition and classification of systemic hypertension in children and adolescents were summarized in table 1

Table 1: Definition and classification of hypertension in children and adolescents

	<i>SBP or DBP Percentile*</i>	<i>Frequency of BP Measurement</i>	<i>Therapeutic Lifestyle Changes</i>	<i>Pharmacologic Therapy</i>
Normal	<90th	Recheck at next scheduled physical examination.	Encourage healthy diet, sleep, and physical activity.	—
Pre hypertension	90th to <95 th or if BP exceeds 120/80 mmHg even if below 90 th percentile up to <95 th percentile [†]	Recheck in 6 months.	Weight-management counseling if overweight, introduce physical activity and diet management. [‡]	None unless Compelling indications such as CKD, diabetes mellitus, heart failure, or LVH exist
Stage 1 hypertension	95th percentile to the 99th percentile plus 5 mmHg	Recheck in 1–2 weeks or sooner if the patient is symptomatic; if persistently elevated on two additional occasions, evaluate or refer to source of care within 1mon	Weight-management counseling if overweight, introduce physical activity and diet management. [‡]	Initiate therapy based on indications in Table 6 or if compelling indications as above.
Stage 2 hypertension	>99th percentile plus 5 mmHg	Evaluate or refer to source of care within 1 week or immediately if the patient is symptomatic.	Weight-management counseling if overweight, introduce physical activity and diet management. [‡]	Initiate therapy. [§]

SBP :systolic blood pressure, **DBP**: diastolic blood pressure, **CKD** ;chronic kidney disease 4thReport on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents. *Pediatrics* 2004

3. Results

In our study ,as shown in figure 1 most of the causes of systemic hypertension were due to renal diseases (85.1%) , cardiac diseases (4.3%) , unknown (2.1%), other causes(Systemic lupus erythematosus ,drug induced as corticosteroid) (8.5%)

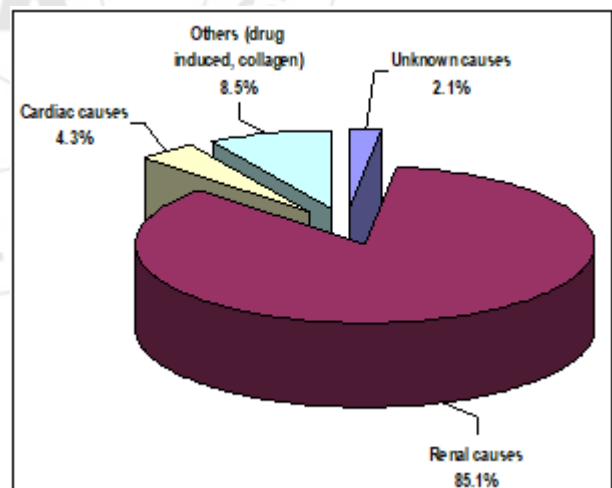


Figure 1: Causes of systemic hypertension in the study group

As shown in table 2 , co-morbid conditions were present in 46.8% of the cases. Drug induced hypertension was the cause in 40.9%, DM in 9.1%, obesity in 18.2%, hypercholesteremia and drug induced in 31.8% of cases

Table 2: co-morbid condition

Associated co-morbid condition present:		
Yes	22	46.8
No	25	53.2
Type of co-morbid condition:		
Drug induced hypertension	9	40.9
Diabetes mellitus	2	9.1
Obeese	4	18.2
On drug inducing hypertension with hypercholesteremia	7	31.8

Table 3: clarifies that complications were present in 53.2% of cases in the form of convulsion (16%), left ventricle hypertrophy (32.0%), retinopathy (32.0%), combined complication (20%)

Table 3: Complications

	No. (n= 47)	%
Complications:		
Present	25	53.2
Absent	22	46.8
Type of complications:		
Convulsion	4	16.0
Left ventricular hypertrophy	8	32.0
Retinopathy	8	32.0
Combined complication	5	20.0

Table 4 shows the laboratory investigations that were done for the study group.

Table 4: Laboratory investigations

	No. (n= 47)	%
Urea, creatinine level:		
Done	47	100.0
Not done	0	0.0
Value:		
High level	30	63.8
Normal	17	36.2
Fasting lipid level:		
Done	7	14.9
Not done	40	85.1
Value:		
High	7	100.0
Normal	0	0.0
Glucose level was done:		
Done	45	95.7
Not done	2	4.3
Value:		
High	2	4.4
Normal	43	95.6
Steroid, catecholamine level:		
Done	1	2.1
Not done	46	97.9
Value:		
Normal	1	100.0
High	0	0.0

As shown in table 5 : Fundus examination was done in 31.9% (86.7% had retinopathy of variant degree) .

Echocardiography was done in 53.2% (36.0% had left ventricular hypertrophy , 28.0% was normal and 36.0% showed other results as *rheumatic heart disease, pericardial effusion , cardiomyopathy*) . Renovascular assessment was done in 4.3 % , (100.0% was normal). Abdominal ultrasound was done in 95.7% (26.7% was normal and 73.3% was abnormal as: ascites, nephropathy with different grades, renal stones)

Table 5: Imaging study

	No. (n= 47)	%
Fundus examination:		
Done	15	31.9
Not done	32	68.1
Result:		
Retinopathy	13	86.7
Normal	2	13.3
Echocardiography		
Done	25	53.2
Not done	22	46.8
Result:		
Left ventricle hypertrophy	9	36.0
Normal	7	28.0
Others	9	36.0
Renovascular assessment:		
Done	2	4.3
Not done	45	95.7
Results:		
Normal	2	100.0
Others	0	0.0
Abdominal US:		
Done	45	95.7
Not done	2	4.3
Results:		
Normal	12	26.7
Abnormal	33	73.3

Table 6 shows that antihypertensive drugs were used in 100% of cases, and proper dose were prescribed in 100% of cases. 27.7% of cases used only one type of drug and 72.3% used more than one type of drugs

Table 6: Anti hypertensive drugs used

	No. (n= 47)	%
Anti-hypertensive drugs:		
Used	47	100.0
Not used	0	0.0
Proper doses:		
Used	47	100.0
Not used	0	0.0
Number of antihypertensive drugs:		
Monotherapy	13	27.7
Polytherapy	34	72.3

Table 7: Reveals antihypertensive drugs used in management of hypertensive emergency

Table 7

Drug	Class	Dose [†]	Route	Comments
Esmolol	β-blocker	100–500 mcg/kg/min	iv infusion	Very short-acting constant infusion preferred. May cause profound bradycardia. Produced modest reductions in BP in a pediatric clinical trial.
Hydralazine	Vasodilator	0.2–0.6 mg/kg/dose	iv, im	Should be given every 4 hours when given iv bolus. Recommended dose is lower than FDA label.
Labetalol	α - and β-blocker	bolus: 0.2–1.0 mg/kg/dose up to 40 mg/dose infusion: 0.25–3.0 mg/kg/hr	iv bolus or infusion	Asthma and overt heart failure are relative contraindications.
Nicardipine	Calcium channel blocker	1–3 mcg/kg/min	iv infusion	May cause reflex tachycardia.
Sodium nitroprusside	Vasodilator	0.53–10 mcg/kg/min	iv infusion	Monitor cyanide levels with prolonged (>72 hr) use or in renal failure; or coadminister with sodium thiosulfate.
Occasionally Useful [‡]				
Drug	Class	Dose*	Route	Comments
Clonidine	Central α-agonist	0.05–0.1 mg/dose may be repeated up to 0.8 mg total dose	po	Side effects include dry mouth and sedation.
Enalaprilat	ACE inhibitor	0.05–0.1 mg/kg/dose up to 1.25 mg/dose	iv bolus	May cause prolonged hypotension and acute renal failure, especially in neonates.
Fenoldopam	Dopamine receptor agonist	0.2–0.8 mcg/kg/min	iv infusion	Produced modest reductions in BP in a pediatric clinical trial in patients up to 12 years.
Isradipine	Calcium channel blocker	0.05–0.1 mg/kg/dose	po	Stable suspension can be compounded.
Minoxidil	Vasodilator	0.1–0.2 mg/kg/dose	po	Most potent oral vasodilator; long-acting.

ACE, angiotensin-converting enzyme; **im**, intramuscular; **iv** intravenous; **po**, oral. *

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Table 8 shows antihypertensive drugs used in hypertensive urgency

Table 8

Furosemide	Diuretic	IV/PO	1–2 mg/kg/dose	Electrolyte disturbances
Isradipine	Ca ⁺⁺ channel blocker	PO	0.05–0.1 mg/kg/dose up to 5 mg/dose	Tachycardia ; headache
Nifedipine	Ca ⁺⁺ channel blocker	Sub-lingual /PO	0.1–0.25 mg/kg/dose	Precipitous drop in blood pressure; tachycardia; headache
Clonidine	Central α agonist	PO	0.05–0.3 mg	Rebound hypertension; sedation
Minoxidil	Vasodilator	PO	0.1–2 mg/kg/dose	Pericardial effusion

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4. Discussion

The study included 47 patients with systemic hypertension admitted to Assiut University Childrens` Hospital . Their ages ranged from 1-17 years , 25(53.19%) of cases were males and 22(46.8%) were females. while in a study performed by Dr Banker ,et al in AHMADABAD ,INDIA (6) they found that the percentage of hypertensive males was (62.5%) and that of females was(37.5 %)

In our study, family history of renal disease is present in 10.6% and of hypertension is present in 2.1%. .One report showed that in adolescents with primary hypertension there is an overall 86 % positive family history of hypertension. (7) .The causes of hypertension observed in the study were due to renal diseases(85.1%) , cardiac diseases (4.3%), unknown (2.1%), other causes (systemic lupus erythematosus ,drug induced as corticosteroid) (8.5%) .

While in a study performed by Dr Radha ,et al in NIZAMABAD , INDIA(8) the etiologies were determined in 97 (92.4%) cases while 8 (7.6%) cases were diagnosed as essential hypertension. Renal parenchymal disease was the most common underlying pathology found in 72 (68.6%) children with hypertension and acute glomerulonephritis was the commonest etiological disease. Others include nephrotic syndrome, chronic glomerulonephritis, reflux nephropathy, obstructive uropathy and reno vascular hypertension (renal artery stenosis), acute renal failure, multiple cystic diseases of kidney and medullary sponge kidney. Hormonal disorders include 1 case of pheochromocytoma and 1 case of hypothyroidism. Miscellaneous diseases associated with hypertension were IDDM, A-V malformation (vein of Galen), tricuspid regurgitation with pulmonary hypertension with CCF, dilated cardiomyopathy.

Fundus examination was done in our study in only 31.9% of cases and of those 86.7% showed retinopathy of variant degree. In a study of 97 children and adolescents with essential hypertension, Daniels et al. [9] found that 51% displayed retinal abnormalities, as detected from direct ophthalmoscopy. We noticed that Echo was done in 53.2% and of those 36.0% was left ventricle hypertrophy, 28.0% was normal, 36.0% show other results as <rheumatic heart disease, pericardial effusion, cardiomyopathy >. But in a study performed by Daniels et al (10) found that 55% of hypertensive children had Left Ventricular Mass Indices (LVMI) above the 99th percentile and 14% had LVMI above 51 g/m (exponent 2.7), a value associated with a fourfold increase in risk of adverse cardiovascular outcomes.

The patients enrolled in the study were advised about therapeutic life style (78.7%), of those patients 100% were advised about reduction of salts and 8.5% were advised about weight reduction. The patients used antihypertensive drugs in 100% of cases, 27.7% of cases were using only one type of drug and 72.3% were using more than one type of drugs. The first drug to be used was ACEI (46.2%) and Furosemide (53.8%). In a study conducted at the University of Maryland Medical Center a total of 72% (N=81) of children and young adults used only one medication while 28% (N=32) used more than one medication. With regard to HTN treatment, we found the first medication prescribed was an ACEI (68%).

5. Conclusion

All the patients enrolled in the study used antihypertensive drugs, 72% of patients were on polytherapy while the rest of patients were on monotherapy. Blood pressure was controlled in all patients on monotherapy but controlled only in 73% of patients on polytherapy. The most common cause of resistant hypertension in uncontrolled patients was due to renal diseases such as chronic renal failure and nephrotic syndrome and rapid progressive glomerulonephritis.

6. Recommendations

- 1) Precautions at measuring BP as suitable cuff size, measuring in lower and upper limb and the patients must be in comfortable position.
- 2) Measuring weight and height of patients to detect BMI and advise for weight reduction in obesity.
- 3) Any elevated BP should be repeated twice and that final classification is based on the average of 3 BP measurement.
- 4) Important adjunctive aspects to the drug therapy of childhood hypertension include ongoing monitoring of target organ damage.
 - a) Fundus exam to exclude retinopathy
 - b) For patients who have LVH, the echocardiographic determination of left ventricular mass index should be repeated periodically
- 5) Counseling regarding other co-morbid condition such as DM, hyperlipidemia, obesity, drug induced hypertension.

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