

## Clinical and Etiological Profile of Pediatric Hypertensive Emergencies

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### Original Research Article

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**Abstract:** Hypertensive emergencies (HTE) in children are relatively rare but life threatening medical emergency. Objectives of the present study were: 1) Find out the incidence, etiology and clinical presentation of HTE 2) Assess real burden of primary hypertension among HTE. A total of 26 children with HTE were studied and the incidence of Hypertension (HTN) was 0.9% while incidence of Hypertensive crisis (HTC) and HTE was 0.5% and 0.3% respectively. Cases were divided into four age groups: infants (< 1 year of age); preschool age (1 to 6 years of age); school going age (6 to 12 years of age); and adolescents (13 to 18 years of age). Adolescents (43%) and school going children (36%) were mostly affected. Male to female ratio was 2.5:1. Primary HTN was noticed in 21% while secondary HTN in 79%. Primary HTN was observed in adolescents (33%) and school going children (20%). All patients presented with Stage 2 HTN. Among secondary HTN 68% patients had intrinsic renal disease as the cause of HTE. Among these, 68% had Glomerulonephritis, 16% obstructive uropathy, 11% reflux nephropathy and 5% Hemolytic uremic syndrome. Apart from renal causes 7% had renovascular, 4% endocrine/oncological as the cause of HTE. In infancy coarctation of aorta was the most common cause of HTE. In preschool, school going and adolescent age groups intrinsic renal disease was the most common cause of HTE followed by renovascular and endocrine causes. Clinical features observed were: dizziness (32%), head ache (29%), nausea and vomiting (29%), chest discomfort (21%), altered sensorium (21%), visual blurring (21%) and convulsions (14%) apart from disease specific symptoms. All patients had end organ damage. Study revealed increasing incidence of primary HTN as a cause of HTE in young school going children though the secondary HTN is still more common and more serious at presentation.

**Keywords:** Hypertensive emergencies, children, increasing, life threatening.

### INTRODUCTION

“As obesity creeps into preschools, and hypertension and type II diabetes become pediatric problems for the very first time, the case for starting preventive health care in the cradle has become too compelling to keep ignoring.” - Heidi Murkoff

Incidence of pediatric hypertension is on rise. The exact cause of this increase is not entirely clear. Many consider it to be a consequence of the coincident obesity epidemic, but the estimated proportion of children afflicted with hypertension is much greater. In the United States the prevalence of HTN has been reported to range from 1-5% in children aged 1 to 18 years [1, 2]. In Taiwan hypertension was found in 0.13% to 0.5% of children aged 6 to 15 years and around 1-3% of children of school age [3]. Incidence from India is unclear. Various authors claimed an incidence of 1-11.5% but the true incidence lies between 1-3% and its prevalence appears to be increasing in school going children [4]. The fourth report from the National High Blood Pressure Education Program (NHBPEP) Working Group on Children and Adolescents and the revised data from

National Health and Nutritional Assessment Survey (NHANAS) 1999–2000 provides evidence that high blood pressure in children may be associated with an elevated cardiovascular risk and markers of target organ damage like ventricular hypertrophy, thickening of the carotid vessel wall, retinal vascular changes, and subtle cognitive changes [5, 6].

Hypertension can be primary/essential where etiology cannot be identified despite an adequate workup or secondary where it is secondary to an identifiable cause. Secondary hypertension accounts for 85-99% of hypertension causes among children below 15 years while primary hypertension accounts for 90% of causes of hypertension in children over 15 years. Population changes in health-related behaviors, including the childhood obesity epidemic, indicate that the rates of primary hypertension in the young are increasing [7-11]. Studies have shown that many of the developing countries including India are facing the dual burden of under-nutrition and over-nutrition [12, 13]. Data from National Family Health Survey 2 (NFHS 2) has identified that significant proportion of over-weight coexists with high rates of malnutrition, pointing that

the nutrition transition is underway in India [14, 15]. Pediatric hypertensive emergencies (HTE) are relatively rare but do represent potentially life threatening medical emergency requiring immediate evaluation and emergency management. In comparison with adults, hypertension in children is mostly asymptomatic and most have no history of hypertension. Additionally, measuring accurate blood pressure values in younger children is not easy and hypertensive crisis (HTC) in children is easily mismanaged in the emergency department. The physician should carefully search for evidence of end organ injury to distinguish between

HTE and hypertensive urgency (HTU). [Table 1 & 2] Only patients with HTE require immediate reduction in markedly elevated blood pressure to prevent and arrest progressive end organ damage. Data on the incidence, causes and clinical presentation of HTE from India is low. Therefore the present study was conducted to find out the incidence, etiology and clinical presentation of HTE and to appraise the real burden of primary hypertension among HTE in children admitting to Pediatric emergency department (ED) of a tertiary care teaching hospital in South India.

**Table-1: Definitions of Hypertension [5]**

S. No	Class	SBP/DBP Percentiles
1	Normotension	< 90 <sup>th</sup> percentile
2	Pre hypertension	≥ 90 <sup>th</sup> to < 95 <sup>th</sup> percentile Adolescents with BP ≥120/80 mm Hg
3	Hypertension	≥95 <sup>th</sup> percentile (average of ≥3 occasions)
4	Stage – 1 hypertension	95 <sup>th</sup> to 99 <sup>th</sup> percentile + 5 mm of Hg
5	Stage – 2 hypertension	>99 <sup>th</sup> percentile + 5 mm of Hg

**Table-2: Definitions of Hypertensive Crisis [5]**

S. No	Class	Definition
1	Hypertensive crisis [HTC]	Hypertensive crisis is an acute rise in BP, and it is further classified into hypertensive emergency and hypertensive urgency. While in adults there are specific cutoffs in BP readings to define hypertensive crisis, no such cutoffs exist in children
2	Hypertensive emergency [HTE]	Hypertensive emergency is defined as acute severe blood pressure elevation with evidence of end-organ damage requiring hospital admission and reduction of BP in hours.
3	Hypertensive urgency [HTU]	High BP which does not pose any immediate risk to cardiovascular or other end organs; the blood pressure may be reduced slowly in 2-3 days, may be managed with oral medications at pediatric emergency department and are followed up on outpatient basis.

**PATIENTS AND METHODS**

**Table 3: Incidence of Pediatric HTN & HTE**

Study period	18months
Total pediatric admission (TPA)	10921
Children presented in PED	5122
Children presented with HTN	94
Children with HTC	57
Children with HTU	29
Children with HTE	28
Incidence of HTN	0.9%
Incidence of HTC	0.5%
Incidence of HTE	0.3%

This prospective study was conducted over a period of 18 months from January 2016 to June 2017. All children from infancy up to and including 18 years of age presenting to Pediatric ED with BP > 99<sup>th</sup> percentile + 5mm of Hg in the presence of acute or ongoing target organ lesions or HTN in relation to an immediate life threatening event requiring immediate intervention to reduce the BP were included in the

study. Neonates, children with BP < 95<sup>th</sup> percentile, BP 95<sup>th</sup> to 99<sup>th</sup> percentile + 5mm Hg, BP > 99<sup>th</sup> percentile + 5mm of Hg in the absence of acute or ongoing target organ lesions, asymptomatic HTN, transient HTN, children with incomplete data and no repeated BP measurements were excluded from the study. After applying exclusion criteria 28 patients with HTE remained in the study. They were divided into four age

groups: infants (< 1 year of age); preschool age (1 to 6 years of age); school going age (6 to 12 years of age); and adolescents (13 to 18 years of age). HTN was defined as a BP between the 95th percentile and 99th percentile plus 5 mmHg (stage 1) and above the 99th percentile plus 5 mmHg (stage 2). All children above one year of age received initial BP measurements at our pediatric ED when triaging. With the exception of children who were bedridden and infants who were unable to sit, BP was checked in a sitting position with their backs supported, feet on the floor, right arm supported, and with the cubital fossa at heart level. An appropriate cuff size was used with an inflatable bladder width that was at least 40% of the arm circumference at a point midway between the olecranon and the acromion. The cuff bladder length covered 80 to 100% of the circumference of the arm. If the systolic BP (SBP) or diastolic BP (DBP) was higher than 120/80 mmHg, it was re-measured in both arms and legs. BP measurements were performed every hour in the patients who presented with an unstable BP and in the patients requiring further observation. Identification of HTN in children more than 12 months of age was defined according to BP standards based on gender, age and height as stipulated in the updated classification of hypertension by the National Blood Pressure Education Program Working Group on Hypertension in Children and Adolescents. When systolic and diastolic percentiles differed, they were categorized according to the higher value. Transient HTN was identified when there was transient elevation of BP caused by any emotional, painful, or uncomfortable events, and HTN was defined as asymptomatic when BP was higher than the 95th percentile only once or twice, but returning to less than the 95<sup>th</sup> percentile on the second or third measurement without any antihypertensive medication. A hypertensive emergency was defined as HTN in the presence of acute or ongoing target-organ lesions or HTN in relation to an immediate life-threatening event requiring immediate intervention to reduce the BP. Hypertensive urgency was defined as an elevation in SBP/DBP higher than the 99th percentile plus 5 mmHg with any complication related to the HTN with no evidence of target-organ lesions. End organ damage was defined as impairment in renal, myocardial, hepatic, and hematologic functions, and neurological manifestations derived from HTN. Acute (transient) end organ damage resulting from HTN was identified by abnormal clinical and laboratory findings which subsided after a decrease in BP. Abnormal data included abnormal electrocardiography findings, impaired renal function tests, elevated liver function markers, and neurological manifestations such as headache, altered consciousness and dizziness. Severe hypertension with symptoms of headache, altered mental status, and posterior leukoencephalopathy on T2-weighted brain magnetic resonance images a diagnosis of hypertensive encephalopathy was made.

The following data was collected and analyzed: age, gender, weight, height, family history of HTN, BP on arrival to the ED, clinical manifestations of hypertensive crisis (dizziness, headache, nausea/vomiting, visual symptoms, seizure/type, altered consciousness, chest tightness/pain, target-organ damage), reversibility with anti hypertension drugs, underlying causes (renal disease, cardiovascular (CV), essential HTN, central nervous system (CNS) factors, endocrine/metabolic disorders, oncological disease), recurrent episodes, brain imaging and duration of hospitalization (ward/ intensive care unit (ICU)). In addition, to decrease the influence of age, exact BMI percentile and z-score (standard deviation score), and SBP/DBP z-score according to the Center for Disease Control (CDC) growth charts were also analyzed. Essential hypertension was diagnosed after excluding secondary causes of hypertension by multiple tests, such as electrocardiography, metabolic panel, renal function tests, hemoglobin and urine routine tests, or other further specific tests including echocardiography, renal ultrasound, plasma rennin activity, plasma aldosterone, thyroid-stimulating hormone and 24-hour urine free cortisol. During the study period, the BP levels, etiology, severity, and clinical manifestations were compared among children by age group. All statistical analyses were performed using Fisher's exact test and or Chi-square test as appropriate. The results of the descriptive analyses of independent variables were reported as percentages. A P-value less than 0.05 were considered statistically significant. Statistical analyses were performed using SPSS software. The data was documented in a proforma and transferred to EXCEL software. Ethical clearance was obtained from Institutional Ethical Committee. No source of funding and no conflict of interest involved in the study.

## RESULTS

During the study period a total of 10921 children were admitted in the Pediatric Department of our Hospital. Of these 5122 children presented to the pediatric ED. Among them HTN cases were 94. Of these 57 presented with hypertensive crisis (HTC) which included 29 cases of hypertensive urgency (HTU) and 28 cases of hypertensive emergency (HTE). Incidence of HTN among total pediatric admissions (TPA) was 0.9% while incidence of HTC and HTE was 0.5% and 0.3% respectively [Table 3]. Age wise distribution of cases was: < 1 yr = 1 [4%]; 1-6 yrs = 5 [17%]; 6-12 yrs = 10 [36%]; 12-18 yrs = 12 [43%]. Overall the most common group affected was adolescent group followed by school going age, preschool age and infancy. Male to female distribution among four groups was 1/0, 3/2, 6/4 and 10/2 with male to female ratio of 1:0, 1.5:1, 1.5:1 and 5:1 among < 1 yr, 1 to 6 yrs, 7 to 12 yrs and 13 to 18 yrs respectively. The overall male to female incidence ratio was 2.5:1. Females were more in school going and preschool age group but no statistically significant disparity among the groups. [P-value 0.7708] A family history of

hypertension was observed in school going children (n=2 of 10 i.e., 20%) and adolescents (n=4 of 12 i.e., 33%). Overall incidence of family history was 21%, seen mostly in adolescents followed by school going children. All of the pediatric HTE patients in the present study presented with hypertension stage 2. Essential hypertension was seen in 2 of 10 (20%) school going children and 4 of 12 (33%) adolescent children with overall incidence of 21%. Remaining 79% children with HTE had secondary hypertension. All the children with essential hypertension had family history of hypertension. The most common cause of secondary hypertension in the infant group was coarctation of aorta. All the other three age groups were found to have intrinsic renal disease as the most common cause of hypertension followed by renovascular and endocrine causes. A total of 19 (68%) patients had intrinsic renal disease as the cause of HTE. Male to female ratio was

3.5:1. Of these 13 (68%) patients presented with Glomerulonephritis (GN), 3 (16%) obstructive uropathy, 2 (11%) reflux nephropathy and 1 (5%) had HUS. 2 patients (7%) had renovascular pathologies – renal artery stenosis in one and coarctation of aorta in the other. One (4%) presented with Pheochromocytoma [Table 4]. Among the clinical variables dizziness was the most common symptom (32%) observed in all the age groups followed by head ache (29%), nausea and vomiting (29%), chest discomfort (21%), altered sensorium (21%), visual blurring (21%) and convulsions (14%) [Table 5]. All the patients had end organ damage: of these 16 (57%) patients presented with hypertensive encephalopathy, 6 (22%) hypertensive retinopathy, 4 (14%) left ventricular hypertrophy and 2 (7%) patients had intra cerebral bleeds.

**Table-4: Etiological variables in Hypertensive**

Emergencies Etiology	Age Group				Total (N = 28)
	< 1 Year	1-6 Years	7-12 Years	13-18 Years	
Renal (n = 19; 68%)					
1. Glomerulonephritis	0	3	6	4	13 (M:F=8:5)
2. Obstructive uropathy	0	1	1	1	3 (M:F=3:0)
3. Reflux nephropathy	0	1	0	1	2 (M:F=2:0)
4. HUS	0	0	1	0	1 (M:F=1:0)
Vascular (n = 2; 7%)					
1. Renal artery stenosis	0	0	0	1	1 (M:F=0:1)
2. Coarctation of aorta	1	0	0	0	1 (M:F=1:0)
Endocrine (n =1; 4%)					
1. Pheochromocytoma	0	0	0	1	1 (M:F=0:1)
Essential HTN (n = 6; 21%)	0	0	2	4	6 (M:F=5:1)

**Table-5: Clinical variables in Hypertensive Emergencies**

Clinical features	Age Group				Total (N = 28)
	< 1 Year	1-6 Years	7-12 Years	13-18 Years	
Headache	0	1	3	4	8
Nausea and Vomiting	1	1	2	4	8
Dizziness	1	2	3	3	9
Chest discomfort	0	1	2	3	6
Altered sensorium	0	1	3	2	6
Visual blurring	0	2	2	2	6
Convulsions	0	1	1	2	4
Family history	0	0	2	4	6
HTN Stage 1	0	0	0	0	0
HTN Stage 2	1	5	10	12	28

**DISCUSSION**

Hypertensive emergency is a life-threatening condition that requires immediate evaluation and treatment. In children severe hypertension can be caused by a variety of underlying conditions. It usually presents with neurological involvement and signs and symptoms of injury to the kidneys, myocardium and eyes can also be present. Hospitalization for intravenous treatment with antihypertensive drugs and close monitoring in an intensive care setting are required for

these patients. With the obesity “epidemic” there has been a rise in the diagnosis of hypertension in pediatric patients, primary hypertension in particular. It is unknown whether the prevalence of HTE has also increased as studies on HTE in children are lacking. Over the last 3 decades, most of the literature published on this subject has encompassed review articles. There are very few original pediatric studies published, and most of them are retrospective and limited to a small number of patients. Therefore the research question

framed for this study was: what are hypertensive emergencies and how a child with hypertensive emergency presents to emergency department? What are the various etiological causes of hypertensive emergencies at different pediatric age groups and why these conditions must be differentiated from hypertensive urgencies? Primary objective of this study was to find out the incidence of hypertensive emergencies among children; to know various causes of hypertensive emergencies at different pediatric age groups and their clinical presentations. The secondary objective was to know the real burden of primary hypertension in causing hypertensive emergencies in children.

The exact prevalence of pediatric HTN worldwide is not known. Based on the use of  $\geq 95$ th percentile to define HTN, it would be expected to be approximately 5%. However, due to the effects of accommodation and regression to the mean with repeated measures, the prevalence of hypertension is lower than 5% and had been expected to be from 1–3% following the recommended three separate measurements in children with an initial BP measurement  $\geq 95$ th percentile [16]. In the western world, the prevalence of hypertension has been reported to range from 1-5% in children aged 1 to 18 years [1, 2]. Various authors from India claimed an incidence of 1-11.5% but the true incidence lies between 1-3%. [4, 17] In the present study the incidence of hypertension was 0.9% of total pediatric admissions. This is similar to the incidence reported by other authors from India: Hari PB *et al.* 1.1% [18] Sunil K Kota *et al.* 1.1% [3] Anand NK *et al.* 0.5% [19] and Pranam GM *et al.* 1.3% [4]. Until now, data on the incidence of hypertensive crisis in children have not been analyzed enough to give a definite result, but in adults, approximately 1% of hypertensive individuals have been reported to have hypertensive crisis. In a retrospective study on children Han-Ping Wu *et al.* reported an incidence of 0.021%. [20] Incidence of HTC and HTE in the present study was 0.5% and 0.3% of total pediatric admissions respectively. Higher incidence reported in the present study reflects increasing incidence of primary hypertension among children with increasing incidence of obesity presenting with end organ damage at younger age.

A total of 26 children with HTE were studied in study. These children were divided into four age groups: infants (< 1 year of age); preschool age (1 to 6 years of age); school going age (6 to 12 years of age); and adolescents (13 to 18 years of age). Most commonly affected were adolescent (43%) and school going age groups (36%). Overall male to female ratio of 2.5:1. Male to female ratio among the four age groups was 1:0, 1.5:1, 1.5:1 and 5:1 in infant, preschool, school going and adolescent age groups respectively. Females were more in preschool and school going ages, but no statistically significant disparity among the groups.

Similar observations were reported by other authors [3, 20, 21].

Essential hypertension was commonly observed in adolescent age (33%) and school going age (20%) with an overall incidence of 21%. Remaining 79% children with HTE had secondary hypertension. Among cases with secondary HTN 68% had intrinsic renal disease as the cause of HTE. Among the renal causes 68% of patients had Glomerulonephritis (membranoproliferative GN 44%, focal segmental GN 33% and crescentic GN 23%); 16% obstructive uropathy; 11% reflux nephropathy and 5% had HUS. Other than renal causes, 7% had renovascular etiology (renal artery stenosis & coarctation of aorta): 4% had endocrine/oncological (Pheochromocytoma) as the cause of HTE. After seven years of age, essential HTN became the major cause of hypertensive emergencies, whereas before that hypertensive emergencies were mostly attributed to secondary HTN. All the children with essential hypertension had family history of hypertension. Our findings are in correlation with those of Yang *et al.* and Chandar *et al.* [21, 22] All of the patients in this study presented with BP levels higher than the 99th percentile plus 5 mmHg (Stage 2 HTN). Yang *et al.* and Martin *et al.* reported that 98% of their patients had Stage 2 HTN [21, 23]. Therefore, the 99<sup>th</sup> percentile plus 5 mmHg may serve as a critical threshold for a high risk of hypertensive crisis in children.

Major symptoms of HTE observed in the present study were: dizziness (32%) observed in all the age groups followed by head ache (29%), nausea and vomiting (29%), chest discomfort (21%), altered sensorium (21%), visual blurring (21%) and convulsions (14%) apart from disease specific symptoms. Yang *et al.* and Martin *et al.* reported similar symptomatology in their patients with hypertensive crisis [21, 23]. In the present study all the patient had end organ damage. 57% presented with hypertensive encephalopathy, 21% with hypertensive retinopathy, 14% with left ventricular hypertrophy and or hypertensive heart failure and 7% presented with intracerebral hemorrhage. Yang *et al.* reported hypertensive encephalopathy in 56%, hypertensive retinopathy in 22% and 22% LVH/CHF. Our results are in concurrence with those of Yang *et al.* [21] The patients with HTE in the current study did not have any mortality or sequelae, permanent neurological damage, blindness, and chronic renal failure have been reported to be long term consequences of hypertensive emergency [23].

## CONCLUSIONS

- Pediatric hypertensive emergencies are relatively rare but potentially life threatening and requires immediate evaluation and emergency management.
- Incidence of pediatric hypertension and hypertensive emergencies is on rise.

- Primary HTN is detectable in school going children and adolescents and can present as HTE.
- Although death and cardiovascular disability do not occur in children with primary hypertension, intermediate markers of target organ damage has been reported.
- Despite the increasing prevalence of essential HTN, common etiologies of secondary HTN must be ruled out because secondary HTN is still more common cause of HTE in this part of the country and is more severe at presentation than essential HTN.

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