

PedsCases Podcast Scripts

This is a text version of a podcast from PedsCases.com on the "Approach to Pediatric Hypertension." These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio version is accessible on iTunes or at www.peds-cases.com/podcasts.

Approach to Pediatric Hypertension

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Introduction

Hi everyone, my name is Dr. Peter Gill, a pediatric resident at the Hospital for Sick Children at the University of Toronto. This podcast was developed with Dr. Seetha Radhakrishnan, a pediatric nephrologist at The Hospital for Sick Children and Assistant Professor at the University of Toronto. This podcast is designed to give you an approach to hypertension in neonates, children and adolescents.

Before we begin, let's start with a clinical case. You are completing your pediatric emergency medicine rotation and your preceptor tells you to go see Janet, a 9-month old girl with a fever. She asks you to take a history, examine the patient, and return when you are finished to present the case. Before you head into the room, you check the patient's vital signs. Her HR is 116, RR 32, BP is 145/81, tympanic temperature of 39.4°C and oxygen saturation of 95% on room air. While you do not know a lot about the difference between adult and pediatric blood pressure ranges, 145/81 is high even for an adult. You ask yourself, do children even get hypertension?

As a medical student, you are familiar with seeing hypertension in adults, but the etiology of elevated blood pressure in children is a foreign concept. With the rising rates of obesity in children, hypertension is becoming a more important issue. In fact, studies suggest that while the prevalence of pediatric hypertension used to be 1%, it now reaches 5%. The American Academy of Pediatrics recommends that all children aged 3 and older have their blood pressure measured at every visit. Certain children are at higher risk of hypertension, and should be screened regularly regardless of age, such as children with Kawasaki disease, obesity, a solid organ transplant, diabetes, chronic kidney disease or nephrotic syndrome.

Learning an approach to pediatric hypertension is important. Therefore, the objectives of this podcast are to:

- 1) Define hypertension in neonates, child and adolescents.
- 2) Develop an approach to pediatric hypertension.
- 3) Identify pertinent features on history and physical exam.
- 4) Review the main differential diagnoses of pediatric hypertension.
- 5) Outline an approach to the initial investigations in a child with hypertension.

Now let's get started.

Definitions

Blood pressure, as the name suggests, is the pressure exerted by circulating blood on vessel walls. Blood pressure varies with heart contraction; systolic pressure is the maximum pressure while diastolic pressure is the minimum pressure. The PedsCases podcast on Pediatric Vital Signs reviews in detail how to measure blood pressure and the normal ranges in children. Briefly, two things are critical to ensure an accurate BP measurement: cuff size and a calm patient. First, the cuff bladder length should wrap around at least 80% of the arm circumference while the bladder width should be at least 40% of the arms circumference. Remember, a small cuff will overestimate blood pressure. Second, if possible, children should be calm and relaxed; crying toddlers will have a high blood pressure.

Normal blood pressure varies with age, height and gender. The upper limit of normal for children varies with age, and accurate blood pressure percentiles are available from the National High Blood Pressure Education Program Working Group, arranged based on age, gender and height.

A persistently elevated blood pressure is defined as hypertension. The official diagnosis of hypertension requires at least 3 measurements of elevated blood pressure using the auscultatory method, which is more reliable than automated measures. An alternate method to diagnose hypertension is using 24-hour ambulatory BP monitoring, where patients have a BP cuff attached for 24-hours and multiple measurements are completed, however this can only be completed in school age children. There are four main categories of blood pressure in children.

- Normal BP is defined as less than the 90th percentile for age, gender and height.
- High-normal blood pressure is between the 90th and 95th percentile.
- Stage 1 hypertension is from the 95th to 99th percentile plus 5 mmHg.
- Stage 2 hypertension is above the 99th percentile plus 5 mmHg.

Differential diagnosis

Essential, idiopathic or primary hypertension is when hypertension is not due to secondary causes like coarctation of the aorta. Before hypertension can be labelled as primary or essential, secondary causes must be ruled out. The differential diagnosis of secondary hypertension is broad, but falls into five main diagnostic categories: renal, cardiac, endocrine, neurologic and medication. A good rule of thumb to remember is that the younger the child, the more likely hypertension is due to a secondary cause.

Renal

Renal diseases are the most common cause of secondary hypertension and can be divided into renovascular diseases, renal parenchymal diseases and anatomic malformations. The most important renovascular disease is renal artery stenosis. Certain children are at risk of developing renal artery stenosis, such as children with neurofibromatosis type 1 and fibromuscular dysplasia. An important risk factor for renal artery stenosis is a history of an umbilical artery catheter as a neonate. Renal parenchymal diseases occur when there is either glomerular or tubular dysfunction. An important cause is reflux nephropathy where children with severe vesicoureteral reflux get renal scarring. Other causes of renal parenchymal diseases include glomerulonephritides, such as post-infectious glomerulonephritis, haemolytic-uremic syndrome and vasculitic diseases like lupus. Lastly, renal anatomic malformations include genetically inherited polycystic kidney diseases and renal tumours.

Cardiac

Coarctation of the aorta is the most common cardiac cause of hypertension with elevated blood pressure only in the upper extremities. While the likelihood of coarctation decreases with age, it

should always be on your differential. Always check the strength and calibre of peripheral pulses. All in all, renal parenchymal disorders and coarctation of the aorta account for approximately 70-90% of all cases of pediatric hypertension.

Endocrine

There are multiple endocrine causes of secondary hypertension. Pheochromocytoma, a tumour in the adrenal gland leading to excessive secretion of catecholamines, classically presents with palpitations, headaches, diaphoresis and hypertension. The easiest way to rule out a pheochromocytoma is to test for urine catecholamines. Hypercalcemia and hyperthyroidism can also cause hypertension, so check electrolytes and TSH in the initial work-up.

Thinking back to basics, the renin-aldosterone angiotensin system plays a major role in blood pressure control. In response to low blood pressure or low sodium, renin is secreted and has three main actions: 1) converts angiotensinogen into its active form which constricts smooth muscles; 2) stimulates the adrenal glands to secrete aldosterone which increases sodium reabsorption; and 3) stimulates thirst. Therefore, a defect in the renin-aldosterone angiotensin system can lead to hypertension, including primary hyperaldosteronism, congenital adrenal hyperplasia and Cushing syndrome.

Neurologic

Elevated intracranial pressure, or ICP, classically presents with an irregular respiratory rate, bradycardia and hypertension, otherwise known as Cushing's triad. Elevated ICP can be secondary to an intracranial bleed, hydrocephalus, brain cancer or pseudotumour cerebri. Pain is an important cause of hypertension; while this is probably not relevant in the outpatient setting, if hospitalized children are hypertensive, ensure to re-check the blood pressure when they are settled. Seizures also lead to transiently elevated blood pressure.

Medications

Medications can lead to hypertension and perhaps the most well known class is steroids. Consider this in children admitted for an asthma exacerbation on high dose steroids, or in the outpatient setting with a child with nephrotic syndrome is on prednisone.

Essential

While there is a whole potpourri of causes of secondary hypertension, essential or primary hypertension is the most common cause in adolescents. In most cases, there is a family history of hypertension. Other risk factors for essential hypertension include obesity and the metabolic syndrome.

History

Before diving into the history, first ask yourself how and why the elevated blood pressure was detected? Was it an incidental finding on routine well-child check or are the presenting symptoms suggestive of symptomatic hypertension? This initial assessment helps determine how urgent your work-up and management needs to be, along with clues on the potential etiology.

Blood pressure itself is usually asymptomatic unless critically high, and if so, symptoms are usually due to end-organ damage. In children, this means headache, visual changes, nose bleeds, chest pain, heart palpitations or seizures. These are alarming symptoms of a hypertensive emergency and mandate urgent treatment.

In children and adolescents, the history should focus on ruling out secondary hypertension, focusing on the cardiac, renal, endocrine and neurological systems. Is there a history of poor urine output, bloody or dark urine? Is there leg or facial swelling, weight loss or failure to thrive? Is there a history of fevers, diaphoresis, flushing or heart palpitations? Is there a history of early or delayed puberty, or short stature? Did the child have recurrent urinary tract infections?

Next, obtained a detailed past medical history. Was the pregnancy normal? Were there any abnormal antenatal ultrasounds or was there oligohydramnios? Was the delivery traumatic? In the newborn period, were they admitted to the NICU, and if so did they ever have an umbilical artery catheter? Is there a prior history of hypertension? Are there any known problems with the urinary tract, such as recurrent urinary tract infections, renal stones or renal cysts? Is there a history of cardiac, neurological or endocrine abnormalities?

Ask about risk factors for hypertension, including diet, exercise, family history, smoking and alcohol if relevant. Is the child on any medications such as steroids, psychostimulants or have they previously been on antihypertensive medications? Was the child ever exposed to nephrotoxic drugs, such as chemotherapy agents or non-steroidal anti-inflammatories? Lastly, obtain a family history. Are there any conditions that run in the family, such as polycystic kidney disease, diabetes mellitus, lupus or pheochromocytoma? Ask about specific genetic conditions like Neurofibromatosis and von Hippel-Lindau. Do any family members have hypertension, diabetes, dyslipidemia or obesity?

Physical exam

With all patients, start with vital signs to ensure they are stable. Check the heart rate, respiratory rate, temperature and oxygen saturation. Repeat the blood pressure at least 2 or 3 times to ensure the reading is accurate. Do your best to ensure the child is calm and relaxed; don't forget blood pressure can be elevated secondary to pain or discomfort. Accurate height and weight are needed to plot growth, and to determine the proper 90th blood pressure range.

On general assessment, look for dysmorphic features which would suggest an underlying genetic or inherited condition, particular in neonates and toddlers. Conditions like neurofibromatosis type I, Marfan's and Turner syndrome have classic exam findings. Does the patient have a cushinoid appearance, or look excessive virilised?

Focus your physical exam to look for causes of secondary hypertension and evidence of end-organ damage. Feel for an enlarged thyroid or neck masses. Complete a focused cranial nerve exam, with particular attention to fundoscopy. Look for papilledema, retinal haemorrhages, arteriovenous nicking or cotton wool spots which would suggest hypertensive emergency.

Next, palpate pulses in all four extremities, taking extra care to feel the strength and character of the femoral pulses. Feel for a brachial-brachial or brachio-femoral delay. Palpate the precordium to see if the apex beat is displaced, which may indicate left ventricular hypertrophy. Auscultate the heart, listening for heart sounds and murmurs. Now examine the abdomen. Palpate for any obvious masses, such as a large neuroblastoma. Palpate for hepatosplenomegaly, and try to palpate each kidney. With your stethoscope, listen for a renal or abdominal bruit. Lastly, complete a detailed skin exam to look for any rashes or skin lesions, such as Cafe-au-lait spots in neurofibromatosis or Ash leaf spots in tuberous sclerosis.

Now let's get back to our case. Janet is a 9-month old girl with fever. The bedside nurse has kindly repeated the blood pressure but the readings are consistently above 140 systolic. Janet has a 2-day history of fever and reduced oral intake. She has no other infectious symptoms and

there are no sick contacts. Past medical history reveals that Janet was a healthy term baby but was admitted once for IV antibiotics for a febrile UTI. Her Mom reports that she's had a couple other febrile episodes with foul-smelling urine that were treated with antibiotics by her family physician. On physical exam, Janet is non-dysmorphic. There are no skin rashes or lesions. Heart sounds are normal, bilateral femoral pulses are strong and the abdomen is soft, non-tender without any masses. The examination is unremarkable with no focus of the fever What do you do next? What investigations should you order?

Investigations

As the potential causes of hypertension are numerous, a step-wise approach to investigations should be taken depending on the setting and patient age. The first step is to confirm the diagnosis of hypertension with multiple measurements. If age appropriate and time permits, complete a 24-hour ambulatory blood pressure monitoring as discussed previously. Obtain a 4-limb blood pressure to determine if there is a difference between upper limbs, or between upper and lower limbs which may suggest coarctation of the aorta.

Get a urinalysis to look for signs of infection, protein or blood. Nitrites and leukocytes are specific markers of a potential urinary tract infection while protein or blood suggest renal inflammation or damage. If you suspect an infection, obtain a urine culture either via catheter or mid-stream urine. Remember, a bagged urine specimen is useless to confirm infection.

Baseline bloodwork should be completed, including a complete blood count, creatinine, urea, serum electrolytes including sodium, potassium, chloride, bicarbonate, calcium, phosphate and magnesium. Make sure you include TSH and Free T4 and Free T3 to rule out thyroid disorders. If the child is obese, complete a metabolic work up which includes a lipid profile, serum glucose and haemoglobin A1c.

All hypertensive children should have an abdominal ultrasound with Dopplers, specifically looking for kidney size, location, echogenicity and renal artery flow. In neonates an echocardiogram is needed to rule out coarctation of the aorta. While waiting for an echo, you could consider a chest x-ray to look for abnormal cardiac anatomy and an ECG. In older children, echocardiogram is mainly to look for evidence of left ventricular hypertrophy.

There are a host of other investigations one can do but they depend on the suspicion for certain diagnoses. You should consider the clinical relevance before sending these tests, as they are likely going to be normal in most children unless there are obvious risk factors. If the initial work-up is negative, it would be reasonable to refer patients to a pediatric nephrologist or cardiologist for further investigations.

Back to our case – the urinalysis is positive for leukocytes and nitrites, but negative for blood and protein. Given the history of UTIs, the lack of a focus on exam, the urinalysis results, and the elevated blood pressure, your preceptor decides to order bloodwork and an abdominal ultrasound. CBC and electrolytes come back normal, while the creatinine and urea just above the reference ranges for age. Abdominal ultrasound shows a normal left kidney, but a smaller right kidney with focal renal scarring. Renal artery Doppler's are normal.

Treatment

We will only briefly touch on treatment in this podcast. If a secondary causes of hypertension is identified, treat the underlying cause. However, if there is a hypertensive emergency, urgent treatment is indicated. Before treatment, consult with your preceptor to ensure you select the

right medication without contraindications. In all patients, lifestyle modifications, weight loss, dietary modification and regular physical activity are encouraged.

Conclusion

Let's conclude our clinical case. Based on the urinalysis, bloodwork and abdominal ultrasound findings, you suspect Janet has a febrile urinary tract infection with evidence of renal scarring. She is admitted to the general pediatrics ward and started on IV antibiotics. The following day, Janet has a voiding cystourethrogram completed, confirming the suspicion of severe vesicoureteral reflux.

This concludes our podcast. Before we leave, here are a few take-home points:

- 1) Hypertension is an important and under-recognized problem in neonates, children and adolescents.
- 2) History and physical exam should focus on ruling out secondary causes of hypertension.
- 3) Use an appropriately sized blood pressure cuff for the individual child. The length of the cuff's bladder should encircle at least 80% of the arm circumference. The bladder width should be at least 40% of the arms circumference.
- 4) Renal parenchymal diseases, renovascular disease and coarctation of the aorta account for the majority of causes of secondary hypertension.
- 5) A step-wise approach to investigations is prudent to rule out secondary hypertension before confirming essential hypertension.

Thanks for listening. Stay tuned for more PedsCases podcasts!

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