Hypertension and Ambulatory Blood Pressure Monitoring in Children

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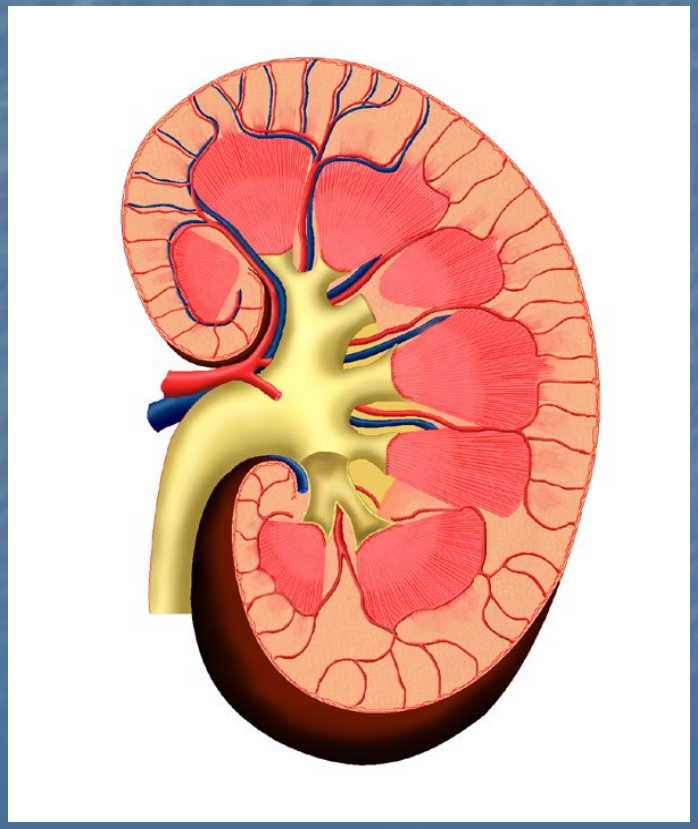
Hypertension

A topic near and dear to my...



Recognizing Hypertension in Children is important because...

- ~3% of U.S. children
  (up to 45% of obese children)
- sign of underlying disease
- end organ damage
- beginning of adult essential HTN

Causes of Elevated BP in Children

- Pain or Fear
- Medications (steroids, tacrolimus)
- Renal issues
- Vascular problems
- Fluid overload
- Obesity-related/Metabolic Syndrome
- Essential

Causes of HTN at Great Ormond Street Hospital for Children

Reflux & obstructive uropathy (scarring)	36%
Glomerulonephritis	23%
Renovascular disease	9.5%
Coarctation of the aorta	8.9%
Polycystic kidney disease	5.5%
Post-Hemolytic Uremic Syndrome	4.0%
Idiopathic/Essential	3.4%
Catecholamine excess states	2.8%
Wilms Tumor	2.4%
Miscellaneous	4.6%

- How Do We Check BP in Children?

Measurement of Blood Pressure in Children

- Children >3 years old should have their BP measured
- Auscultation is the preferred method of BP measurement
- Elevated BP must be confirmed on repeated measurement
- BP >90th percentile obtained by oscillometric devices should be repeated by auscultation

Measurement of Blood Pressure in Children

- Correct measurement requires a cuff that is appropriate to the size of the child's upper arm
  - Main source of error – Using wrong cuff size
  - Small cuff- overestimates BP
  - Large cuff- underestimates BP

Definitions of Hypertension

- **Hypertension**—average SBP and/or DBP that is greater than or equal to the 95th percentile for sex, age, and height on 3 or more occasions.

- **Prehypertension**—average SBP or DBP levels that are greater than or equal to the 90th percentile, but less than the 95th percentile.
  - Adolescents with BP levels greater than or equal to120/80 mmHg should be considered prehypertensive.

- **White-coat hypertension**—A patient with BP levels above the 95th percentile in a physician's office or clinic, who is normotensive outside a clinical setting (ambulatory BP monitoring is usually required to make this diagnosis).

Pediatric Symptoms

- Hypertension is often thought of as a silent disease because typically there have not been any classic symptoms
- A study by Croix found that 51% of untreated hypertensive children when surveyed reported 1-4 Symptoms, and 14% reported more than four symptoms
- 3 most common symptoms
  - headache
  - difficulty initiating sleep
  - daytime tiredness

  These were all reduced with treatment

Using the BP Tables

1. Use height charts to determine percentile
2. Measure and record the child's SBP and DBP.
3. Use the correct gender table for SBP and DBP.
4. Find the child's age on the left side of the table. Follow the age row horizontally across the table to the intersection of the line for the height percentile (vertical column).

Using the BP Tables

5. SBP percentiles in the left columns and DBP percentiles in the right columns.

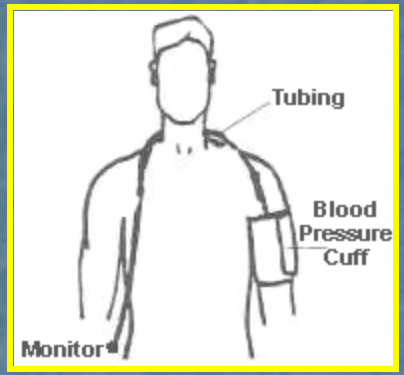
- **Normal BP** = < the 90th percentile
- **Prehypertension** = BP between the 90th and 95th percentile or > 120/80 mmHg in adolescents
- **Hypertension** = BP > than the 95th percentile on repeated measurement

Using the BP Tables

6. BP > the 90th percentile should be repeated twice at the same office visit.
7. BP > the 95th percentile should be staged
   - Stage 1 = 95th percentile to the 99th percentile plus 5 mmHg
   - Stage 2 = >99th percentile plus 5 mmHg

Ambulatory Blood Pressure Monitor (ABPM)

- Small, quiet
- 24 hours
- Many measurements
- Home, school, work
- Awake, asleep



Benefits of ABPM

- No terminal digit preference
- No observer bias
- High reproducibility in adult studies
- It captures the inherent variability of Blood Pressure
- Data!

Average Blood Pressure

Averages for
time spent awake

Averages for
time spent asleep

Diurnal Blood Pressure Pattern

Dipper

or

Nondipper

Who is not dipping?

- BP control dissociated from autonomic nerves

  Diabetes mellitus, autonomic neuropathy, pheochromocytoma
- Increased corticosteroids

  Cushing's syndrome, iatrogenic
- BP control dissociated from control organs

  Chronic renal failure, renal transplant, heart transplant, renal artery stenosis

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Normal

Patient Information

Name: [redacted]
ID: [redacted]
Date-of-Birth: [redacted]
Age: 14 Years
Medications: Dose: Time:
None

Gender: Female
Height: 62 Inches
Weight: 138 Pounds
Race: Caucasian
Physician: Ettinger,Leigh
Nurse/Technician: Picarelli,Catherine
Duration: 23:40
Scan Start: 07/08/14 09:34 Tue
Scan End: 07/09/14 09:14 Wed
Successful Reading(s): 56 89%
Indications: Suspected white-coat hypertension

Overall Summary

	AVG	STD		MIN	MAX	Dipping
Systolic:	101	11.43	mmHg	77 (01:44 Wed)	125 (10:14 Tue)	17.0%
Diastolic:	64	9.36	mmHg	41 (01:44 Wed)	82 (10:34 Tue)	19.5%
MAP:	79	9.15	mmHg	55	97	14.7%
Pulse Pressure:	38	7.21	mmHg	22	63	
Heart Rate:	80	8.18	bpm	67	109	

	Reading(s)	Time
Percent of Systolic above limits:	0%	0%
Percent of Diastolic above limits:	1.8%	2.1%

Wake Period(s) 07:00 - 23:00

	AVG	STD		MIN	MAX
Systolic:	106	8.81	mmHg	88 (12:54 Tue)	125 (10:14 Tue)
Diastolic:	67	7.64	mmHg	49 (12:54 Tue)	82 (10:34 Tue)
MAP:	82	7.62	mmHg	65	97
Pulse Pressure:	39	7.30	mmHg	22	63
Heart Rate:	81	8.45	bpm	67	109

	Reading(s)	Time
Percent of Systolic readings > 128mmHg:	0%	0%
Percent of Diastolic readings > 82mmHg:	0%	0%

Number of Wake Period(s) readings: 42

Sleep Period(s) 23:00 - 07:00

	AVG	STD		MIN	MAX
Systolic:	88	7.88	mmHg	77 (01:44 Wed)	103 (06:44 Wed)
Diastolic:	54	7.97	mmHg	41 (01:44 Wed)	69 (06:44 Wed)
MAP:	70	8.37	mmHg	55	83
Pulse Pressure:	34	5.54	mmHg	28	45
Heart Rate:	79	7.47	bpm	69	93

	Reading(s)	Time
Percent of Systolic readings > 114mmHg:	0%	0%
Percent of Diastolic readings > 66mmHg:	7.1%	3.3%

Number of Sleep Period(s) readings: 14

Interpretation

This was a study of good quality with 89% of attempted readings obtained. The 2014 Update on ABPM in Children and Adolescents (AHA) was used to interpret the data. Fiona had a daytime average of 106/67 mmHg, which was normotensive. Her asleep average was also within normal limtis. All of her BP loads (percent of time hypertensive) were within acceptable limits. Her diurnal pattern was normal with a 17% dip in average BP while asleep. In sum, this was a normal study that showed that Fiona has normal BPs with no risk factors for end organ damage. There is no need for further intervention now. The 24 hour monitor can be repeated in a few years if office BPs remain high.

Signed **Date**

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Borderline
(Diabetic x 10 years)

Patient Information

Name: [redacted]
ID: [redacted]
Date-of-Birth: [redacted]
Age: 16 Years
Gender: Male
Height: 63 Inches
Weight:
Race: Caucasian
Physician: Ettinger,Leigh
Nurse/Technician: Picarelli,Catherine
Duration: 23:40
Scan Start: 08/28/14 11:48 Thu
Scan End: 08/29/14 11:28 Fri
Successful Reading(s): 54 86%
Indications: Suspected white-coat hypertension

Medications:	Dose:	Time:
Glucophage		10:30 Fri
Glucophage		13:00 Thu
Glucophage		20:00 Thu

Overall Summary

	AVG	STD		MIN	MAX	Dipping
Systolic:	123	20.70	mmHg	80 (08:08 Fri)	168 (15:48 Thu)	16.8%
Diastolic:	74	17.89	mmHg	47 (09:48 Fri)	129 (15:48 Thu)	31.0%
MAP:	87	17.44	mmHg	52	132	25.0%
Pulse Pressure:	49	12.24	mmHg	21	71	
Heart Rate:	84	10.92	bpm	64	110	

	Reading(s)	Time
Percent of Systolic above limits:	35.2%	37.2%
Percent of Diastolic above limits:	40.7%	42.3%

Wake Period(s) 10:00 - 01:00

	AVG	STD		MIN	MAX
Systolic:	131	19.92	mmHg	95 (10:28 Fri)	168 (15:48 Thu)
Diastolic:	84	15.33	mmHg	51 (10:28 Fri)	129 (15:48 Thu)
MAP:	96	15.01	mmHg	64	132
Pulse Pressure:	48	12.57	mmHg	23	70
Heart Rate:	88	10.19	bpm	64	110

	Reading(s)	Time
Percent of Systolic readings > 133mmHg:	50.0%	48.0%
Percent of Diastolic readings > 81mmHg:	58.8%	56.6%

Number of Wake Period(s) readings: 34

Sleep Period(s) 01:00 - 10:00

	AVG	STD		MIN	MAX
Systolic:	109	12.52	mmHg	80 (08:08 Fri)	138 (01:08 Fri)
Diastolic:	58	6.56	mmHg	47 (09:48 Fri)	77 (08:31 Fri)
MAP:	72	7.80	mmHg	52	82
Pulse Pressure:	50	11.74	mmHg	21	71
Heart Rate:	77	8.92	bpm	66	103

	Reading(s)	Time
Percent of Systolic readings > 118mmHg:	10.0%	8.7%
Percent of Diastolic readings > 66mmHg:	10.0%	6.5%

Number of Sleep Period(s) readings: 20

Interpretation

This was a study of good quality with 86% of attempted readings obtained. The 2014 Update on ABPM in Children and Adolescents (AHA) was used to interpret the data. Lucas had a daytime average BP of 131/84 mmHg (nl SBP but high DBP). His asleep BP average was within normal limits. His awake BP loads (percentage of time hypertensive) were elevated. His asleep BP loads were normal. His diurnal pattern was normal with a 16.8% dip in average BP while asleep. In sum, this was an abnormal study that showed that Lucas had daytime DBP hypertension with risk factors for end organ damage.

Signed **Date**

	Systolic:	Diastolic:	MAP:	PP	HR
Auto Edit Limit Max:	240	150	200	150	200
Auto Edit Limit Min:	70	40	40	20	20

Printed:10/08/14 16:22:37 Wed

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severe
Hypertension

Patient Information

Name: [redacted]
ID: [redacted]
Date-of-Birth: [redacted]
Age: 16 Years
Medications: Dose: Time:

Gender: Female
Height: 185 Centimeters
Weight: 125 Kilograms
Race: African-American
Physician: Ettinger,Leigh
Nurse/Technician: Picarelli,Catherine
Duration: 23:19
Scan Start: 04/28/14 16:02 Mon
Scan End: 04/29/14 15:21 Tue
Successful Reading(s): 52 81%
Indications: Suspected white-coat hypertension

Overall Summary

	AVG	STD		MIN	MAX	Dipping
Systolic:	175	18.50	mmHg	139 (05:31 Tue)	212 (11:24 Tue)	14.3%
Diastolic:	100	14.32	mmHg	69 (05:31 Tue)	130 (03:34 Tue)	17.2%
MAP:	120	14.12	mmHg	93	152	15.9%
Pulse Pressure:	75	11.07	mmHg	53	101	
Heart Rate:	81	9.05	bpm	63	100	

	Reading(s)	Time
Percent of Systolic above limits:	100%	100%
Percent of Diastolic above limits:	88.5%	85.6%

Wake Period(s) 07:00 - 23:00

	AVG	STD		MIN	MAX
Systolic:	182	13.52	mmHg	147 (07:21 Tue)	212 (11:24 Tue)
Diastolic:	105	9.75	mmHg	80 (07:01 Tue)	129 (13:41 Tue)
MAP:	126	9.51	mmHg	102	152
Pulse Pressure:	77	11.59	mmHg	54	101
Heart Rate:	83	7.90	bpm	64	100

	Reading(s)	Time
Percent of Systolic readings > 132mmHg:	100%	100%
Percent of Diastolic readings > 86mmHg:	97.4%	92.6%

Number of Wake Period(s) readings: 38

Sleep Period(s) 23:00 - 07:00

	AVG	STD		MIN	MAX
Systolic:	156	16.85	mmHg	139 (05:31 Tue)	202 (03:34 Tue)
Diastolic:	87	16.53	mmHg	69 (05:31 Tue)	130 (03:34 Tue)
MAP:	106	14.89	mmHg	93	144
Pulse Pressure:	69	6.98	mmHg	53	79
Heart Rate:	74	8.95	bpm	63	91

	Reading(s)	Time
Percent of Systolic readings > 119mmHg:	100%	100%
Percent of Diastolic readings > 78mmHg:	64.3%	61.7%

Number of Sleep Period(s) readings: 14

Interpretation

This was a study of good quality with 81% of attempted readings obtained. The 2004 AAP BP guideliens wre used to intepret the data. Amarys had severe daytime hypertension with an average daytime BP of 182/105 mmg. Her asleep BP average was also in the hypertensive range. All of her BP loads (percentage of time spent hypertensive) were elevated. Her diurnal pattern was normal with a 14% dip in average BP while asleep. In sum, this was an abnormal study with severe daytime hypertension with risk factors for end organ damage.

Signed **Date**

	Systolic:	Diastolic:	MAP:	PP	HR
Printed:10/08/14 16:22:59 Wed					
Auto Edit Limit Max:	240	150	200	150	200
Auto Edit Limit Min:	70	40	40	20	20

After Hypertension is Diagnosed

- Want to rule out secondary causes
- BP should be measured in both arms and a leg to rule out coarctation of the aorta
- Fasting lipid, Fasting glucose, standard chemistry panel, serum urea nitrogen (BUN), CBC, creatinine, urinalysis and urine culture
- Echocardiogram, renal ultrasound
- Screen for major sleep disorders using BEARS:
  - Bedtime problems
  - Excessive daytime sleepiness
  - Awakenings during the night
  - Regularity and duration of sleep
  - Snoring

After Hypertension is Diagnosed

- Puberty is a changing point for finding underlying disease. Before puberty 90% of HTN has an underlying cause and 10% is essential. After puberty the ratio inverts to 90% essential and 10% underlying cause. The differential for the underlying cause is extensive. The underlying cause may be treatable with medical or surgical intervention.

- Adult hypertension has to start sometime and there is growing awareness that it is starting in adolescence.

Additional recommendations provided in the Fourth Report:

- Clinical evaluation of confirmed HTN
- Therapeutic lifestyle changes
- Indications for evaluation for secondary hypertension, co-morbidities
- Indications for pharmacological therapy
- Antihypertensive drugs approved for use in hypertensive children

The Dash Diet

Eating right is a big part of controlling hypertension.

The government's DASH (dietary approaches to stop hypertension) diet can help, providing menus low in salt and calories and high in nutrients.

- **Nuts, Seeds, Beans**
  All kinds of legumes and nuts—including almonds, filberts, peanuts, sunflower seeds, kidney beans and lentils—are fine. Just hold them to fewer than five servings a week. The size of a serving depends on the food.

- **Meat, Fowl, Fish**
  Up to two servings a day are fine. The key is to keep the portions under control—about 3 oz.—and prepare them well: select lean cuts; trim visible fat; avoid salt; and broil, roast or boil instead of fry. The DASH menus provide tips on spices, seasonings and sauces.

- **Vegetables**
  Up to five servings a day of fruits and another five of vegetables are a big part of the DASH plan. Green leafy plants like bitter greens are a good choice, but so are many more familiar vegetables, including potatoes (baked, not fried).

Menus are available at: http://nhlbi.nih.gov/health (Look under Recipe Collections.)

Photo by AMY REICHMAN / ENVISION

Food Selection to Decrease Caloric and Increase Nutrient Intake

- **GO Foods**—Eat almost anytime.
- **SLOW Foods**—Eat sometimes, at most several times a week.
- **WHOA Foods**—Eat only once in a while or for special treats.

From Go to Slow to Whoa: The Importance of How To Prepare Food			
	GO	**SLOW**	**WHOA**
Vegetable	Plain baked potato	Baked potato with 1 tsp butter and 1 tsp sour cream	French fries
Bread	Slice of toast	Slice of French toast	Doughnut
Meat	Skinless chicken breast	Chicken with skin	Fried chicken

Source: Behavioral Risk Factor Surveillance System, CDC.

Exercise: 1 hour per day of Moderate Intensity

The Talk Test

If you are able to Sing = Light Intensity

If you can Talk = Moderate Intensity

If you are Winded = Vigorous Intensity

Live It

Wean the Screen

For most Americans, one of the biggest challenges to being more physically active is the amount of time families spend in front of a screen—TV, video games, and computers.

It's time to wean the screen. Setting and agreeing on a certain number of hours each day of "screen time" is important. Health experts recommend that screen time be limited to two hours or less a day that is not work- or homework-related time, such as watching documentary films, doing research, or writing on a computer.

Find out some helpful ways to reduce screen time.

Additional recommendations provided in the Fourth Report:

- Clinical evaluation of confirmed HTN
- Therapeutic lifestyle changes
- Indications for evaluation for secondary hypertension, co-morbidities
- Indications for pharmacological therapy
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Pharmacologic Therapy

- Indicated when lifestyle modifications are ineffective, when there are symptoms, when there is secondary hypertension, or when there is end organ damage
- Choice of agent is up to the clinician, with the recommendation that those with proteinuric renal diseases or diabetes mellitus receive an ACE inhibitor or an ARB

Pharmacologic Therapy

- ACE Inhibitors (angiotensin converting enzyme) i.e. lisinopril, enalapril
- ARB (angiotensin receptor blocker) i.e. Cozaar, Diovan
  - Contraindicated in pregnancy
  - Routine monitoring of K, creatinine
  - Dry cough (seen more with ACE)

Pharmacologic Therapy

- a and b antagonist (labetalol)
- b antagonist (metaprolol,atenolol,propanolol)
  - Asthma, heart failure are relative contraindications.
  - Heart rate is dose-limiting.
  - May impair athletic performance in athletes.
  - Should not be used in insulin-dependent DM

Pharmacologic Therapy

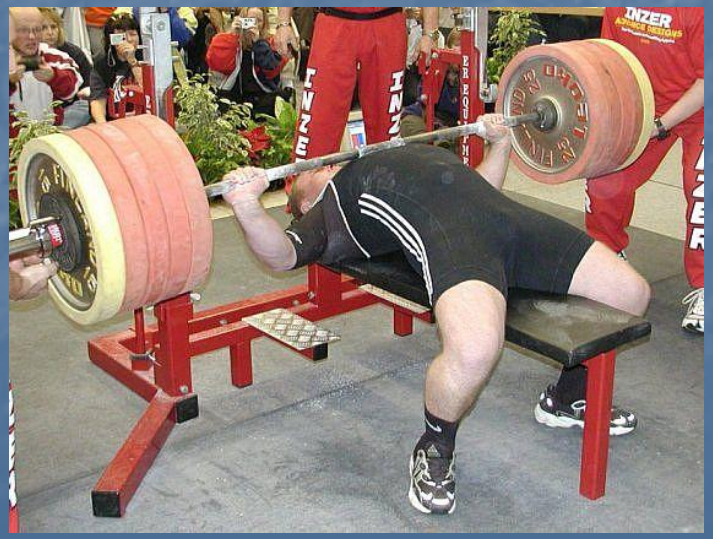
- Calcium Channel Blockers (amlodipine)
  - May cause tachycardia
  - May cause edema
- Diuretics
  - All patients treated with diuretics should have electrolytes monitored periodically
  - Most useful as add-on therapy in patients being treated with drugs from other drug classes

AAP guidelines 2008 Medical Conditions Affecting Sports Participation

Sports Participation with Hypertension

"A Qualified Yes"

Those with hypertension >5 mmHg above the 99th percentile for age, gender, and height (ie Stage 2 Hypertension) should avoid heavy weightlifting and power lifting, bodybuilding, and high-static component sports.



Athletic Participation by Children and Adolescents Who have Systemic Hypertension (AAP, June, 2010)

- Asymtomatic Athletes with Pre-HTN and Essential HTN should be encouraged to play
- Athletes with Stage 2 hypertension and/or symptoms and/or LVH should be restricted from high-static activities until their BP is controlled with medicine, and then play

I hope that this is not too burdensome... but, if you think it is, you are not alone.

"*The sphygmomanometer would not be welcomed by the overworked and underpaid general practitioner already loaded with thermometer, stethoscope, etc*."

Blake E., Recent British researches on arterial tension. Med Times Gaz, 1895;23:29.

Conclusion

- Hypertension and obesity in children are increasing in an upward trend
- It is imperative that pediatric hypertension is recognized and treated
- It is important to encourage healthy lifestyles in all children and adolescents and help institute lifestyle changes for weight reduction in overweight children

Resources

- Flynn JT, Daniels SR, Hayman LL, Maahs DM, McCrindle BW, Mitsnefes M, Zachariah JP, Urbina EM; on behalf of the American Heart Association Atherosclerosis, Hypertension and Obesity in Youth Committee of the Council on Cardiovascular Disease in the Young. Update: ambulatory blood pressure monitoring in children and adolescents: a scientific statement from the American Heart Association. *Hypertension*. 2014;63:1116–1135.

- National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics. 2004; 114 (Suppl 2): 555–576.