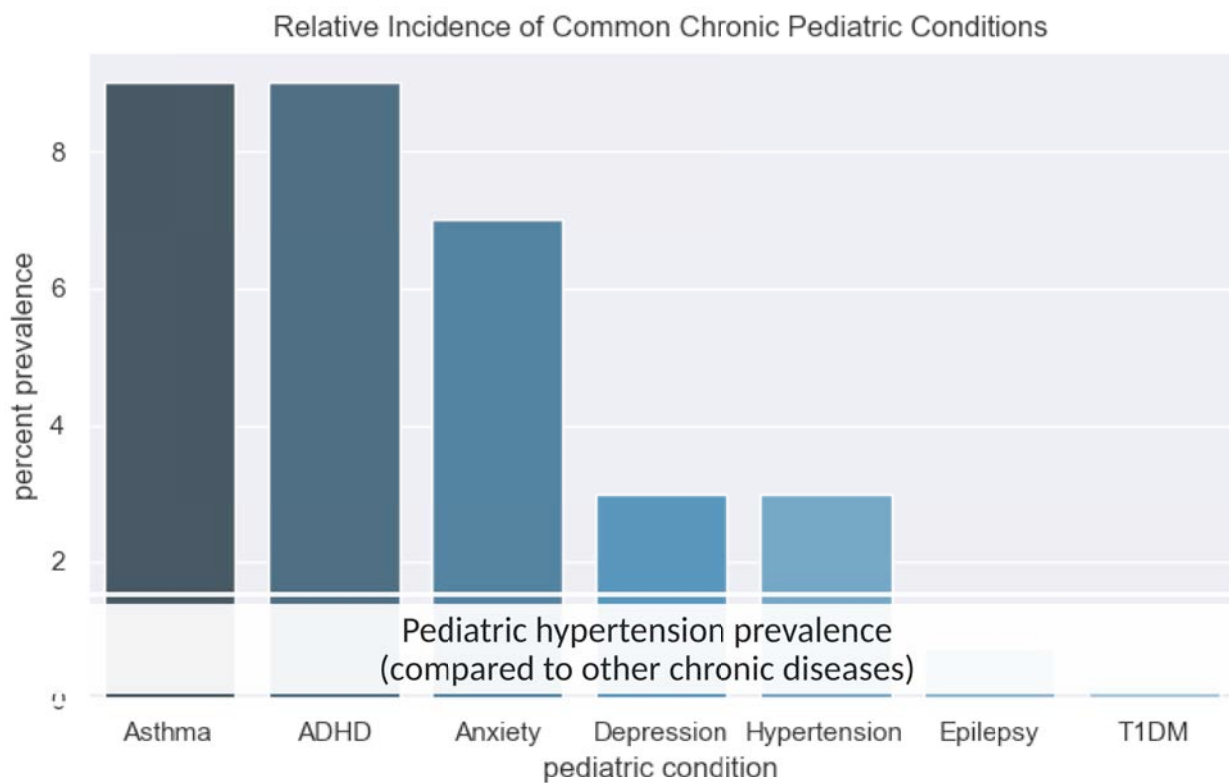


# Pediatric Hypertension Management

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# 2017 AAP Guidelines: What's Hypertension?

Compare multiple readings to new percentile norms for age and height:

Age (y)	BP Percentile	SBP (mm Hg)						
		Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6
	Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9
	50th	85	85	86	86	87	88	88
	90th	98	99	99	100	100	101	101
	95th	102	102	103	103	104	105	105
	95th + 12 mm Hg	114	114	115	115	116	117	117

50<sup>th</sup> - normal BP



90<sup>th</sup> - elevated BP



95<sup>th</sup> - stage 1 HTN



95<sup>th</sup> + 12 - stage 2 HTN



## Measure BP properly

- **Bad patient prep:**

- Cold office (↑)
- Nicotine/caffeine ingestion <30 min (↑)
- Full bladder (↑)

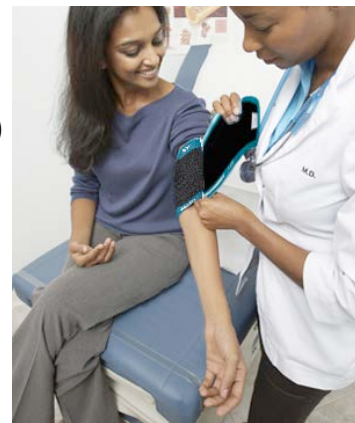
- **Bad patient positioning:**

- Constrictive clothing/unbared arm (↑)
- Moving/talking (↑)
- Unsupported arm/unsupported back/unsupported feet (↑)
- Arm not at level of right atrium:
  - Arm lower: ↑
  - Arm higher: ↓

Plz no ->



<- wrong



<- never do this

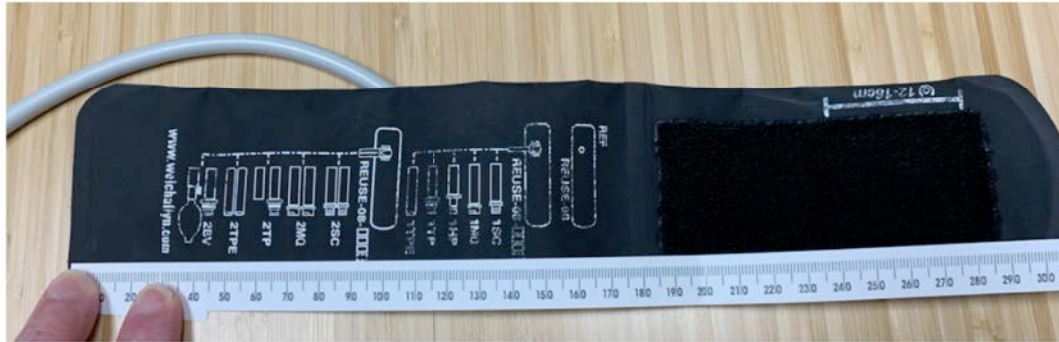
# Measure BP properly

- **Bad cuff size:**

- Cuff bladder width should be 40%+ of the circumference of the middle of the upper arm
- Cuff bladder length should be 80%+ of the circumference of the middle of the upper arm
- Cuff too big: ↓
- Cuff too small: ↑

Example cuff sizes

cuff size (cm)	name
4 x 8	newborn
6 x 12	infant
9 x 18	child
12 x 22	small adult
16 x 30	adult
16 x 36	large adult
16 x 42	extra-large adult



# Measure BP properly

- **Bad measurement:**

- Manual: Letting pressure out too quickly (↓ PP)
- Oscillometric: Not rechecking high BP manually

- **Bad machine:**

- Uncalibrated aneroid sphygmomanometer

# New guidelines: dx of hypertension

If BP >90<sup>th</sup>, repeat 2x and average. If average is not in normal range:

If average is...	Actions	If still at this level at first F/U visit:	If still at this level at second F/U visit:
Elevated BP (>90 <sup>th</sup> )	Lifestyle counseling, +/- nutrition referral; recheck in 6 mo.	Check 4 ext BP, repeat lifestyle counseling, see back in 6 more months	ABPM to confirm, screening labs, +/- specialist
Stage 1 htn (>95 <sup>th</sup> )	Lifestyle counseling, +/- nutrition referral; recheck 1-2 weeks.	Check 4 ext BP, repeat lifestyle counseling, see back in 3 more months	ABPM to confirm, screening labs, +/- specialist, treat.
Stage 2 htn (>95 <sup>th</sup> + 12)**	Lifestyle counseling, check 4 ext BP, recheck <1 week OR send to specialist <1 week	ABPM to confirm, screening labs, and treatment, OR send to specialist <1 week	**If >95 <sup>th</sup> + 30 mmHg OR 180/120 OR Stage 2 & symptomatic, to ER

If  $\geq 95^{\text{th}}$  on 3 different visits -> diagnose hypertension

## The role of ABPM in kids

BP is not static!

- Useful to distinguish HTN vs white coat hypertension (30-50% of elevated pediatric BP)
  - Cost-saving if done prior to labs, echo, referral, Rx
  - Cost-saving if done in PCP office (\$1265 at children's hospital!)
- Useful to identify masked hypertension (obesity, coarct repair)
- Only reliable way to look for nocturnal dipping vs. non-dipping
- Use in evaluation of moderate to severe OSA (even after AT)
- Good for data when deciding on med changes

## Screening Tests: Look for 2ary htn causes

- For all:

- Urinalysis
- BMP
- Lipid panel
- If <6 yo or abnormal U/A, renal function

- If obese, also:

- HbA1c
- AST/ALT

- Depending on patient:

- Fasting glucose
- TSH
- Drug screen
- Sleep study
- CBC

Verdict on other studies:

- Echocardiogram – do when starting meds
- Renal ultrasound, CTA, MRA – consult with specialist
- EKG – not useful as screening for LVH
- Nuclear renography – not useful
- Serum uric acid – not useful
- Microalbuminuria – not useful in kids

## How do I pick an ABPM machine?

AAP Guideline recommends:

- Dabl Educational table of validated devices  
([http://www.dableducational.org/sphygmomanometers/devices\\_3\\_abpm.html](http://www.dableducational.org/sphygmomanometers/devices_3_abpm.html))

Also consider:

- British & Irish Hypertension Society ABPM page (<https://bihsoc.org/bp-monitors/for-specialist-use/>)
- See what authors use in pediatric ABPM studies
- Ask your favorite peds nephrologist/cardiologist

**BE SURE YOUR CHOICE HAS A WAY TO INTERPRET PEDIATRIC STUDIES**

# ABPM in kids: How does it work?



## 24 Hour Ambulatory Blood Pressure Monitor



### DEVICE BUTTONS

Note To stop a measurement, press any button.

	<b>Start button</b>	<ul style="list-style-type: none"> <li>Starts the automatic protocol</li> <li>Triggers a measurement in addition to the automatic protocol</li> </ul>
	<b>Event button</b>	Records an event and triggers an additional measurement.
	<b>Day/Night button</b>	Patient presses immediately before going to sleep and upon waking.
	<b>On/Off button</b>	Turns on or off device, press for two seconds.

### Helpful Tips:

1. **Keep your arm still when the device starts-** moving your arm will give an error
2. **Press the event button-** Press this button if you are participating in an extracurricular activity (i.e. Baseball, Soccer, Football, etc.) or if you are experiencing anxiety (i.e. taking a test)
3. **Press the day/night button-** once you go to bed and when you wake up; however, if you forget, it's ok, readings will still occur.



### More Helpful Tips:

1. **Do not** take a bath, shower or go swimming with the device on.
2. **Do not** turn off the device at any time.
3. **Do not** take off the device unless you are experiencing pain, swelling, redness or numbness on the arm where the cuff is placed, or unless directed to do so by your provider.
4. **Do not** go to the ER if you get an error message or a high reading.



*If you have any questions while wearing the device, call our office at (931) 707-8700!*

5. **Do not** remove batteries at anytime.

# ABPM results

- 1) Machine gives log
- 2) Discard outlier measurements
- 3) Assess adequacy
- 4) Compute:
  - **Mean SBP & DBP** for total, day, and night
  - **BP load** for SBP & DBP (load = % of readings above >95<sup>th</sup> %ile)
  - **Dipping** (percent day/night difference)

## Welch Allyn CardioPerfect Workstation

Name: Berman, Simon  
 Number: 101  
 Gender: Male  
 Birthdate: 2/25/2003 17 years  
 Comment: Ht 178.2cm, wt: 65.9kg

Recorded: 6/1/2020 12:55:00 PM  
 Read back: 6/1/2020 3:00:00 PM  
 Recorded by:  
 Referring physician:  
 Location:  
 UNCONFIRMED INTERPRETATION

Nr.	Date & Time	Syst.	MAP	Diast.	HR	PP	RPP	Comment
1	6/1/2020 12:55:00	107	87	70	101	37	10807	Manual measurement
Event	6/1/2020 12:57:00							Error measurement (nr. 7)
2	6/1/2020 1:00:00	118	94	73	81	45	9558	
3	6/1/2020 1:20:00	91	80	72	89	19	8099	
4	6/1/2020 1:43:00	90	65	44	63	46	5670	
5	6/1/2020 2:00:00	109	82	59	58	50	6322	
6	6/1/2020 2:23:00	77	64	53	68	24	5236	
7	6/1/2020 2:43:00	117	82	53	82	64	9594	
8	6/1/2020 3:00:00	121	98	79	62	42	7502	
Event	6/1/2020 3:21:00							On/Off button pressed
Event	6/1/2020 3:25:00							On/Off button pressed
Event	6/1/2020 3:25:01							Error measurement (nr. 7)
Event	6/1/2020 3:25:02							On/Off button pressed

# ABPM Interpretation

Compare computed values to tables of ABPM age/height/sex-based norms:

measuremen	sex	percentile	height_120	height_125	height_130	height_13	height_14	height_14	height_14	height
24-h SBP	M	50th	104.5	105.3	106.2	107.2	108.3	109.5	110.	
24-h SBP	M	75th	109.2	110.1	111.1	112.1	113.3	114.6	116.	
24-h SBP	M	90th	113.8	114.8	115.9	116.9	118.2	119.5	121.	
24-h SBP	M	95th	116.8	117.8	118.9	120.0	121.2	122.5	124.	
24-h SBP	M	99th	122.9	123.9	125.0	126.1	127.3	128.6	130.	
Daytime SBP	M	50th	110.8	111.1	111.5	112.0	112.7	113.7	115.	
Daytime SBP	M	75th	116.2	116.5	116.9	117.4	118.0	119.0	120.	
Daytime SBP	M	90th	121.7	121.9	122.2	122.5	123.0	123.9	125.	
Daytime SBP	M	95th	125.2	125.3	125.5	125.7	126.0	126.9	128.	
Daytime SBP	M	99th	132.6	132.4	132.2	132.0	132.1	132.8	134.	
Nighttime SB	M	50th	93.6	94.6	95.6	96.7	97.9	99.0	100.	
Nighttime SB	M	75th	98.6	99.8	101.0	102.3	103.6	104.7	105.	
Nighttime SB	M	90th	103.3	104.8	106.3	107.8	109.3	110.6	111.	
Nighttime SB	M	95th	106.3	107.9	109.7	111.4	113.0	114.4	115.	

Mean SBP:	110.33		
SBP percentile (age):	<50th	SBP percentile (height):	<50th
Mean DBP:	63.0		
DBP percentile (age):	<50th	DBP percentile (height):	<50th
Day mean SBP:	112.5		
Day mean DBP:	71.5		
Day load thresholds (age):	145.0 / 91.0	Day load thresholds (height):	137.6 / 82.1
Day load (age):	['0.0 %', '0.0 %']	Day load (height):	['0.0 %', '0.0 %']
Night mean SBP:	109.25		
Night SBP percentile (age):	<50th	Night SBP percentile (height):	<50th
Night mean DBP:	58.75		
Night DBP percentile (age):	<50th	Night DBP percentile (height):	<50th
Night load thresholds (age):	128.0 / 76.0	Night load thresholds (height):	120.9 / 66.1
Night load (age):	['0.0 %', '25.0 %']	Night load (height):	['25.0 %', '25.0 %']
Dipping:	2.89 % / 17.83 %		

# ABPM Interpretation

Interpret according to table

Classification	Office BP*	Mean Ambulatory SBP or DBP†‡	SBP or DBP Load, %‡§
Normal BP	<90th %tile	<95th %tile	<25
White coat hypertension	≥95th %tile	<95th %tile	<25
Prehypertension	≥90th %tile or >120/80 mm Hg	<95th %tile	≥25
Masked hypertension	<95th %tile	>95th %tile	≥25
Ambulatory hypertension <sup>¶</sup>	>95th %tile	>95th %tile	25–50
Severe ambulatory hypertension (at risk for end-organ damage)	>95th %tile	>95th %tile	>50

## Hypertension treatment

- Goal: reduce SBP and DBP to <90<sup>th</sup> %ile (<130/80 in adolescents)  
(No sports clearance until end organ risk assessed & no Stage 2 HTN)
- Start meds for:
  - Patient has failed >6 months of lifestyle change
  - Symptomatic hypertension
  - Stage 2 hypertension
- Follow up:
  - Lifestyle change only: q 3-6 months
  - Meds: q 4-6 weeks for dose adjustments until goal reached then q 3-4 months



# Choice of meds

- Lisinopril:
  - Initial dose 0.07 mg/kg/day (max 5 mg)
  - Titrate upwards as high as 0.6 mg/kg/day (max 40 mg) divided daily
  - Liquid (1 mg/ml) and tabs (2.5 mg, 5 mg, 10 mg, 20 mg, 30 mg, 40 mg)
  - \$5-10 cash for 1 month supply of tabs
- Losartan:
  - Initial dose: 0.7 mg/kg/day (max 50 mg)
  - Titrate upwards as high as 1.4 mg/kg (max 100 mg)
  - Liquid (2.5 mg/ml compounded) and tabs (25 mg, 50 mg, 100 mg)
  - \$15-30 cash for 1 month supply of tabs
- Hydrochlorothiazide:
  - Initial dose: 1 mg/kg/day (max 25 mg)
  - Titrate upwards as high as 3 mg/kg/day (max 50 mg) divided daily or BID
  - Tabs (12.5, 25, 50 mg)
  - \$5-10 cash for 1 month supply of tabs

# Approach to HTN QI in general pediatrics

## Population-based:

- Who's had their BP checked at a well visit? (67-84%, 2012)
- Who's had their BP checked at other recommended intervals? (35%, 2012)
- Who's had elevated BPs?
- Were elevated BPs noted by the physician? (13%, 2010)
- Who's had elevated BP rechecks on schedule?
- Who's had 3 elevated BP and had their chart marked? (26%, 2007)
- Who's had appropriate screening/ABPM/treatment instituted?

## Risk-based:

- Do I have the charts marked for all kids who are high-risk for HTN?
- When did these kids last have casual BP/ABPM assessed?

## ROI

- 99211 for placement & nurse teaching
  - National Medicare fee (2020): \$23.46
- 93784 for recording, upload, interpretation, report
  - National Medicare fee (2020): \$47.28 (wRVU 0.38)

Cost of machine: \$1500-\$3000  
(including cuffs and software)

Cost of staff to set up each patient:  
\$10 - \$15

Cost of physician interpretation:  
\$14 (wRVU @ \$36 or 3.5 min @  
\$250/hr)

Less cost of end-to-end referral  
tracking: \$2-7

Revenue \$71, cost-per \$26-36; net-per \$35-45, machine pays for itself after 33-85 uses

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