

Update on Paediatric Hypertension Guidelines

NC Fong
PMH



Declaration

- ▶ No conflict of interest

Background

- ▶ Last Paediatric HT guidelines by NHLBI in **2004**
- ▶ Increase in prevalence of HT due to **obesity**
- ▶ Paediatric HT translates into **adult HT**, what is known as the tracking phenomenon
- ▶ **AAP** published new guidelines in Paediatric HT in **2017**
- ▶ Useful for clinicians seeing children both in hospital and **outpatient setting**

American Academy
of Pediatrics



DEDICATED TO THE HEALTH OF ALL CHILDREN

Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents

Joseph T. Flynn, MD, MS, FAAP,^a David C. Kaelber, MD, PhD, MPH, FAAP, FACP, FAGMI,^b Carissa M. Baker-Smith, MD, MS, MPH, FAAP, FAHA,^c Douglas Blowey, MD,^d Aaron E. Carroll, MD, MS, FAAP,^e Stephen R. Daniels, MD, PhD, FAAP,^f Sarah D. de Ferranti, MD, MPH, FAAP,^g Janis M. Dionne, MD, FRCPC,^h Bonita Falkner, MD,ⁱ Susan K. Flinn, MA,^j Samuel S. Gidding, MD,^k Celeste Goodwin,^l Michael G. Leu, MD, MS, MHS, FAAP,^m Makia E. Powers, MD, MPH, FAAP,ⁿ Corinna Rea, MD, MPH, FAAP,^o Joshua Samuels, MD, MPH, FAAP,^p Madeline Simasek, MD, MSCP, FAAP,^q Vidhu V. Thaker, MD, FAAP,^r Elaine M. Urbina, MD, MS, FAAP,^s SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN

PEDIATRICS Volume 140, number 3, September 2017

Guidelines

2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents

Empar Lurbe^{a,b}, Enrico Agabiti-Rosei^c, J. Kennedy Cruickshank^d, Anna Dominiczak^e, Serap Erdine^f, Asle Hirth^g, Cecilia Invitti^h, Mieczyslaw Litwinⁱ, Giuseppe Mancia^j, Denes Pall^k, Wolfgang Rascher^l, Josep Redon^{b,m,n}, Franz Schaefer^o, Tomas Seeman^p, Manish Sinha^q, Stella Stabouli^r, Nicholas J. Webb^s, Elke Wühl^t, and Alberto Zanchetti^u

Journal of Hypertension • Volume 34 • Number 10 • October 2016



Canadian Journal of Cardiology 36 (2020) 596–624

Guidelines

Hypertension Canada's 2020 Comprehensive Guidelines for the Prevention, Diagnosis, Risk Assessment, and Treatment of Hypertension in Adults and Children

Doreen M. Rabi, MD, MSc,^a Kerry A. McBrien, MD, MPH,^b

Ruth Sapir-Pichhadze, MD, MSc, PhD,^c Meranda Nakhla, MD, MSc,^d

Sofia B. Ahmed, MD, MMSc,^e Sandra M. Dumanski, MD,^c Sonia Butalia, BSc, MD, MSc,^f

Alexander A. Leung, MD, MPH,^a Kevin C. Harris, MD, MHSc,^g Lyne Cloutier, RN, PhD,^h

Kelly B. Zarnke, MD, MSc,ⁱ Marcel Ruzicka, MD, PhD,^j Swapnil Hiremath, MD, MPH,^k

Ross D. Feldman, MD,^l Sheldon W. Tobe, MD, MScCH,^m

Tavis S. Campbell, PhD, RPsych,ⁿ Simon L. Bacon, PhD,^o Kara A. Nerenberg, MD, MSc,^p

George K. Dresser, MD, PhD,^q Anne Fournier, MD,^r Ellen Burgess, MD,^s

Patrice Lindsay, RN, PhD,^t Simon W. Rabkin, MD,^u Ally P.H. Prebtani, MD,^v

7 important changes



1. New Definition of Paediatric Hypertension

Definition of Hypertension (1-18yr)

TABLE 1. Updated Definitions of Pediatric BP Categories and Stages

	FOR CHILDREN AGED 1-<13 Y	FOR CHILDREN AGED ≥13 Y
Normal BP	<90th percentile	<120/<80 mm Hg
Elevated BP	≥90th percentile to <95th percentile or 120/80 mm Hg to <95th percentile (whichever is lower)	120/<80–129/<80 mm Hg
Stage 1 HTN	≥95th percentile to <95th percentile + 12 mm Hg or 130/80–139/89 mm Hg (whichever is lower)	130/80–139/89 mm Hg
Stage 2 HTN	≥95th percentile + 12 mm Hg or ≥140/90 mm Hg (whichever is lower)	≥140/90 mm Hg

BP=blood pressure, HTN=hypertension.

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2017;140(3):e20171904

TABLE 4 BP Levels for Boys by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
13	Height (in)	57.9	59.1	61	63.1	65.2	67.1	68.3	57.9	59.1	61	63.1	65.2	67.1	68.3
	Height (cm)	147	150	154.9	160.3	165.7	170.5	173.4	147	150	154.9	160.3	165.7	170.5	173.4
	50th	103	104	105	108	110	111	112	61	60	61	62	63	64	65
	90th	115	116	118	121	124	126	126	74	74	74	75	76	77	77
	95th	119	120	122	125	128	130	131	78	78	78	78	80	81	81
	95th + 12 mm Hg	131	132	134	137	140	142	143	90	90	90	90	92	93	93
14	Height (in)	60.6	61.8	63.8	65.9	68.0	69.8	70.9	60.6	61.8	63.8	65.9	68.0	69.8	70.9
	Height (cm)	153.8	156.9	162	167.5	172.7	177.4	180.1	153.8	156.9	162	167.5	172.7	177.4	180.1
	50th	105	106	109	111	112	113	113	60	60	62	64	65	66	67
	90th	119	120	123	126	127	128	129	74	74	75	77	78	79	80
	95th	123	125	127	130	132	133	134	77	78	79	81	82	83	84
	95th + 12 mm Hg	135	137	139	142	144	145	146	89	90	91	93	94	95	96
15	Height (in)	62.6	63.8	65.7	67.8	69.8	71.5	72.5	62.6	63.8	65.7	67.8	69.8	71.5	72.5
	Height (cm)	159	162	166.9	172.2	177.2	181.6	184.2	159	162	166.9	172.2	177.2	181.6	184.2
	50th	108	110	112	113	114	114	114	61	62	64	65	66	67	68
	90th	123	124	126	128	129	130	130	75	76	78	79	80	81	81
	95th	127	129	131	132	134	135	135	78	79	81	83	84	85	85
	95th + 12 mm Hg	139	141	143	144	146	147	147	90	91	93	95	96	97	97
16	Height (in)	63.8	64.9	66.8	68.8	70.7	72.4	73.4	63.8	64.9	66.8	68.8	70.7	72.4	73.4
	Height (cm)	162.1	165	169.6	174.6	179.5	183.8	186.4	162.1	165	169.6	174.6	179.5	183.8	186.4
	50th	111	112	114	115	115	116	116	63	64	66	67	68	69	69
	90th	126	127	128	129	131	131	132	77	78	79	80	81	82	82
	95th	130	131	133	134	135	136	137	80	81	83	84	85	86	86
	95th + 12 mm Hg	142	143	145	146	147	148	149	92	93	95	96	97	98	98
17	Height (in)	64.5	65.5	67.3	69.2	71.1	72.8	73.8	64.5	65.5	67.3	69.2	71.1	72.8	73.8
	Height (cm)	163.8	166.5	170.9	175.8	180.7	184.9	187.5	163.8	166.5	170.9	175.8	180.7	184.9	187.5
	50th	114	115	116	117	117	118	118	65	66	67	68	69	70	70
	90th	128	129	130	131	132	133	134	78	79	80	81	82	82	83
	95th	132	133	134	135	137	138	138	81	82	84	85	86	86	87
	95th + 12 mm Hg	144	145	146	147	149	150	150	93	94	96	97	98	98	99

TABLE 5 BP Levels for Girls by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height													
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
13	Height (in)	58.3	59.3	60.9	62.7	64.5	66.1	67	58.3	59.3	60.9	62.7	64.5	66.1	67
	Height (cm)	148.1	150.6	154.7	159.2	163.7	167.8	170.2	148.1	150.6	154.7	159.2	163.7	167.8	170.2
	50th	104	105	106	107	108	108	109	62	62	63	64	65	65	66
	90th	116	117	119	121	122	123	123	75	75	75	76	76	76	76
	95th	121	122	123	124	126	126	127	79	79	79	79	80	80	81
	95th + 12 mm Hg	133	134	135	136	138	138	139	91	91	91	91	92	92	93
14	Height (in)	59.3	60.2	61.8	63.5	65.2	66.8	67.7	59.3	60.2	61.8	63.5	65.2	66.8	67.7
	Height (cm)	150.6	153	156.9	161.3	165.7	169.7	172.1	150.6	153	156.9	161.3	165.7	169.7	172.1
	50th	105	106	107	108	109	109	109	63	63	64	65	66	66	66
	90th	118	118	120	122	123	123	123	76	76	76	76	77	77	77
	95th	123	123	124	125	126	127	127	80	80	80	80	81	81	82
	95th + 12 mm Hg	135	135	136	137	138	139	139	92	92	92	92	93	93	94
15	Height (in)	59.7	60.6	62.2	63.9	65.6	67.2	68.1	59.7	60.6	62.2	63.9	65.6	67.2	68.1
	Height (cm)	151.7	154	157.9	162.3	166.7	170.6	173	151.7	154	157.9	162.3	166.7	170.6	173
	50th	105	106	107	108	109	109	109	64	64	64	65	66	67	67
	90th	118	119	121	122	123	123	124	76	76	76	77	77	78	78
	95th	124	124	125	126	127	127	128	80	80	80	81	82	82	82
	95th + 12 mm Hg	136	136	137	138	139	139	140	92	92	92	93	94	94	94
16	Height (in)	59.9	60.8	62.4	64.1	65.8	67.3	68.3	59.9	60.8	62.4	64.1	65.8	67.3	68.3
	Height (cm)	152.1	154.5	158.4	162.8	167.1	171.1	173.4	152.1	154.5	158.4	162.8	167.1	171.1	173.4
	50th	106	107	108	109	109	110	110	64	64	65	66	66	67	67
	90th	119	120	122	123	124	124	124	76	76	76	77	78	78	78
	95th	124	125	125	127	127	128	128	80	80	80	81	82	82	82
	95th + 12 mm Hg	136	137	137	139	139	140	140	92	92	92	93	94	94	94
17	Height (in)	60.0	60.9	62.5	64.2	65.9	67.4	68.4	60.0	60.9	62.5	64.2	65.9	67.4	68.4
	Height (cm)	152.4	154.7	158.7	163.0	167.4	171.3	173.7	152.4	154.7	158.7	163.0	167.4	171.3	173.7
	50th	107	108	109	110	110	110	111	64	64	65	66	66	66	67
	90th	120	121	123	124	124	125	125	76	76	77	77	78	78	78
	95th	125	125	126	127	128	128	128	80	80	80	81	82	82	82
	95th + 12 mm Hg	137	137	138	139	140	140	140	92	92	92	93	94	94	94

Table 2 Definition of normotension and hypertension

	European guidelines		US guidelines		
	< 16 years	≥ 16 years	< 13 years	≥ 13 years	
Normotension	< 90th %ile	< 130/85	Normotension	< 90th %ile*	< 120/80
High-normal BP	≥ 90th %ile–< 95th %ile	130–139/85–90	Elevated BP	≥ 90th %ile*–< 95th %ile	120–130/80
Grade I HTN	≥ 95th %ile–99th %ile + 5 mmHg	140–159/90–99	Stage I HTN	≥ 95th %ile–< 95th %ile + 12 mmHg [£]	130/80–139/89
Grade II HTN	> 99th %ile + 5 mmHg	160–179/100–109	Stage II HTN	≥ 95th %ile + 12 mmHg [£]	≥ 140/90
Isolated systolic HTN	SBP > 95th %ile and DBP < 90th %ile	SBP > 140 and DBP < 90	Isolated systolic HTN	Not addressed	Not addressed
Immediate referral to ED	Severe HTN [±] associated with life threatening condition	Severe HTN [±] associated with life threatening condition	Immediate referral to ED	> 95th %ile + 30mmHg [¥]	> 180/120 [¥]

US United States, BP blood pressure, SBP systolic blood pressure, DBP diastolic blood pressure, HTN hypertension, ED emergency department

*Or 120/80, whichever lower

[£] Or 130/80–139/89, whichever lower

[£] Or 140/90, whichever lower

[±] Defined by some as 20% above grade II limit

[¥] Or stage II with symptoms

Implications for practice

- ▶ Align with American Heart Association/American College of Cardiology **ADULT** guidelines
- ▶ Smooth transition to adult practice
- ▶ > 13 years = adult ? -- AAP
- ▶ > 16 years = adult ? -- Europe

2. New Normative Blood Pressure Tables

New Normative Blood Pressure Tables

- ▶ 2004 normative BP tables
 - ▶ from BP readings of ~70,000 healthy children including **overweight children**
- ▶ 2017 **New** normative BP tables
 - ▶ based only on readings of ~50,000 **normal weight children** from **2004** data

New Normative BP Tables

TABLE 4 BP Levels for Boys by Age and Height Percentile

Age (y)	BP Percentile	SBP (mm Hg)								DBP (mm Hg)					
		Height Percentile or Measured Height								Height Percentile or Measured Height					
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	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	77.2	78.3	80.2	82.4	84.6	86.7	87.9
	50th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
	90th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
	95th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
	95th + 12 mm Hg	114	114	115	115	116	117	117	66	66	67	67	68	69	69
2	Height (in)	33.9	34.4	35.3	36.3	37.3	38.2	38.8	33.9	34.4	35.3	36.3	37.3	38.2	38.8
	Height (cm)	86.1	87.4	89.6	92.1	94.7	97.1	98.5	86.1	87.4	89.6	92.1	94.7	97.1	98.5
	50th	87	87	88	89	89	90	91	43	43	44	44	45	46	46
	90th	100	100	101	102	103	103	104	55	55	56	56	57	58	58
	95th	104	105	105	106	107	107	108	57	58	58	59	60	61	61
	95th + 12 mm Hg	116	117	117	118	119	119	120	69	70	70	71	72	73	73
3	Height (in)	36.4	37	37.9	39	40.1	41.1	41.7	36.4	37	37.9	39	40.1	41.1	41.7
	Height (cm)	92.5	93.9	96.3	99	101.8	104.3	105.8	92.5	93.9	96.3	99	101.8	104.3	105.8
	50th	88	89	89	90	91	92	92	45	46	46	47	48	49	49
	90th	101	102	102	103	104	105	105	58	58	59	59	60	61	61
	95th	106	106	107	107	108	109	109	60	61	61	62	63	64	64
	95th + 12 mm Hg	118	118	119	119	120	121	121	72	73	73	74	75	76	76
4	Height (in)	38.8	39.4	40.5	41.7	42.9	43.9	44.5	38.8	39.4	40.5	41.7	42.9	43.9	44.5
	Height (cm)	98.5	100.2	102.9	105.9	108.9	111.5	113.2	98.5	100.2	102.9	105.9	108.9	111.5	113.2
	50th	90	90	91	92	93	94	94	48	49	49	50	51	52	52
	90th	102	103	104	105	105	106	107	60	61	62	62	63	64	64
	95th	107	107	108	108	109	110	110	63	64	65	66	67	67	68
	95th + 12 mm Hg	119	119	120	120	121	122	122	75	76	77	78	79	79	80
5	Height (in)	41.1	41.8	43.0	44.3	45.5	46.7	47.4	41.1	41.8	43.0	44.3	45.5	46.7	47.4
	Height (cm)	104.4	106.2	109.1	112.4	115.7	118.6	120.3	104.4	106.2	109.1	112.4	115.7	118.6	120.3
	50th	91	92	93	94	95	96	96	51	51	52	53	54	55	55
	90th	103	104	105	106	107	108	108	63	64	65	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mm Hg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
6	Height (in)	43.4	44.2	45.4	46.8	48.2	49.4	50.2	43.4	44.2	45.4	46.8	48.2	49.4	50.2
	Height (cm)	110.3	112.2	115.3	118.9	122.4	125.6	127.5	110.3	112.2	115.3	118.9	122.4	125.6	127.5
	50th	93	93	94	95	96	97	98	54	54	55	56	57	57	58
	90th	105	105	106	107	109	110	110	66	66	67	68	68	69	69
	95th	108	109	110	111	112	113	114	69	70	70	71	72	72	73
	95th + 12 mm Hg	120	121	122	123	124	125	126	81	82	82	83	84	84	85
7	Height (in)	45.7	46.5	47.8	49.3	50.8	52.1	52.9	45.7	46.5	47.8	49.3	50.8	52.1	52.9
	Height (cm)	116.1	118	121.4	125.1	128.9	132.4	134.5	116.1	118	121.4	125.1	128.9	132.4	134.5
	50th	94	94	95	97	98	98	99	56	56	57	58	58	59	59
	90th	106	107	108	109	110	111	111	68	68	69	70	70	71	71
	95th	110	110	111	112	114	115	116	71	71	72	73	73	74	74
	95th + 12 mm Hg	122	122	123	124	126	127	128	83	83	84	85	85	86	86

New Normative BP Tables

TABLE 4 Continued

Age (y)	BP Percentile	SBP (mm Hg)								DBP (mm Hg)						
		Height Percentile or Measured Height								Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%	
8	Height (in)	47.8	48.6	50	51.6	53.2	54.6	55.5	47.8	48.6	50	51.6	53.2	54.6	55.5	
	Height (cm)	121.4	123.5	127	131	135.1	138.8	141	121.4	123.5	127	131	135.1	138.8	141	
	50th	95	96	97	98	99	99	100	57	57	58	59	59	60	60	
	90th	107	108	109	110	111	112	112	69	70	70	71	72	72	73	
	95th	111	112	112	114	115	116	117	72	73	73	74	75	75	75	
	95th + 12 mm Hg	123	124	124	126	127	128	129	84	85	85	86	87	87	87	
9	Height (in)	49.6	50.5	52	53.7	55.4	56.9	57.9	49.6	50.5	52	53.7	55.4	56.9	57.9	
	Height (cm)	126	128.3	132.1	136.3	140.7	144.7	147.1	126	128.3	132.1	136.3	140.7	144.7	147.1	
	50th	96	97	98	99	100	101	101	57	58	59	60	61	62	62	
	90th	107	108	109	110	112	113	114	70	71	72	73	74	74	74	
	95th	112	112	113	115	116	118	119	74	74	75	76	76	77	77	
	95th + 12 mm Hg	124	124	125	127	128	130	131	86	86	87	88	88	89	89	
10	Height (in)	51.3	52.2	53.8	55.6	57.4	59.1	60.1	51.3	52.2	53.8	55.6	57.4	59.1	60.1	
	Height (cm)	130.2	132.7	136.7	141.3	145.9	150.1	152.7	130.2	132.7	136.7	141.3	145.9	150.1	152.7	
	50th	97	98	99	100	101	102	103	59	60	61	62	63	63	64	
	90th	108	109	111	112	113	115	116	72	73	74	74	75	75	76	
	95th	112	113	114	116	118	120	121	76	76	77	77	78	78	78	
	95th + 12 mm Hg	124	125	126	128	130	132	133	88	88	89	89	90	90	90	

Screening BP Tables

TABLE 2. Screening BP Values Requiring Further Evaluation

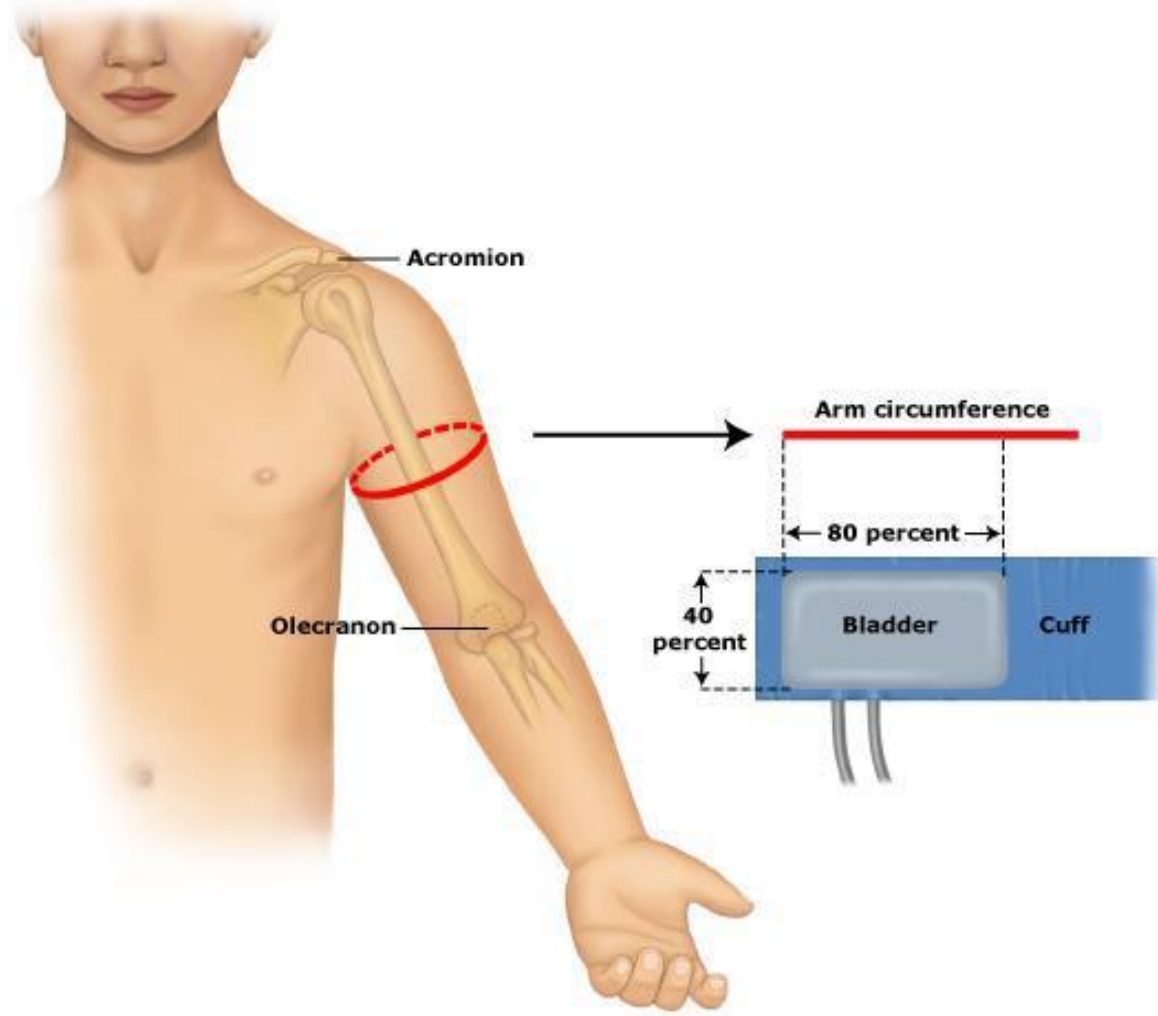
AGE, Y	BLOOD PRESSURE, MM HG			
	BOYS		GIRLS	
	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC
1	98	52	98	54
2	100	55	101	58
3	101	58	102	60
4	102	60	103	62
5	103	63	104	64
6	105	66	105	67
7	106	68	106	68
8	107	69	107	69
9	107	70	108	71
10	108	72	109	72
11	110	74	111	74
12	113	75	114	75
≥13	120	80	120	80

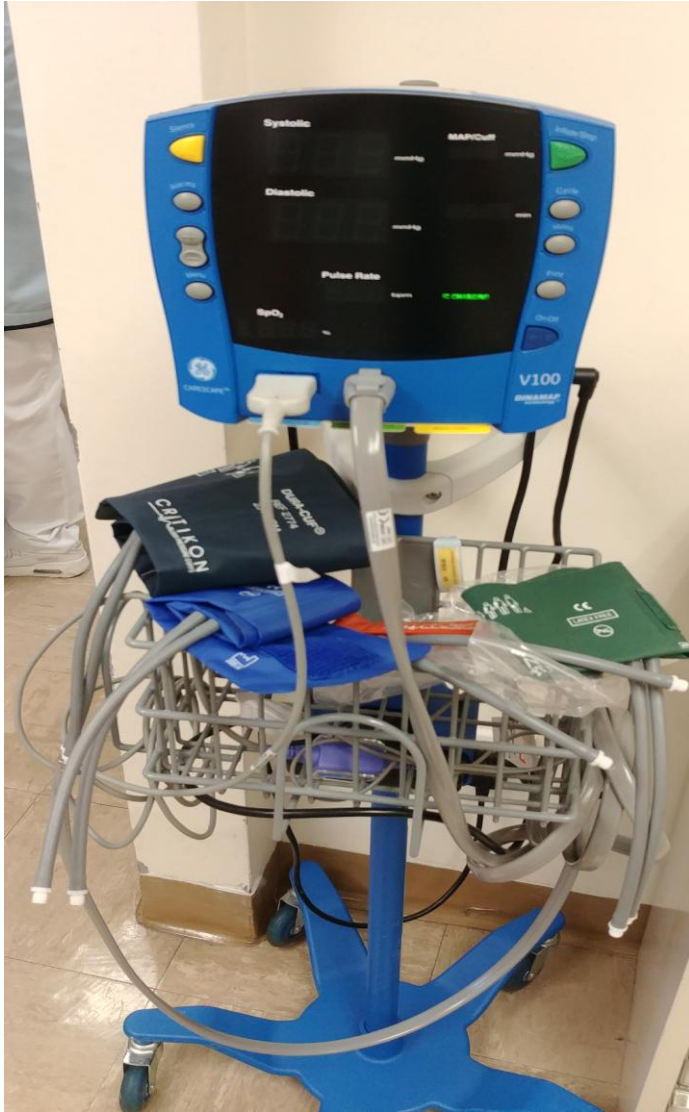
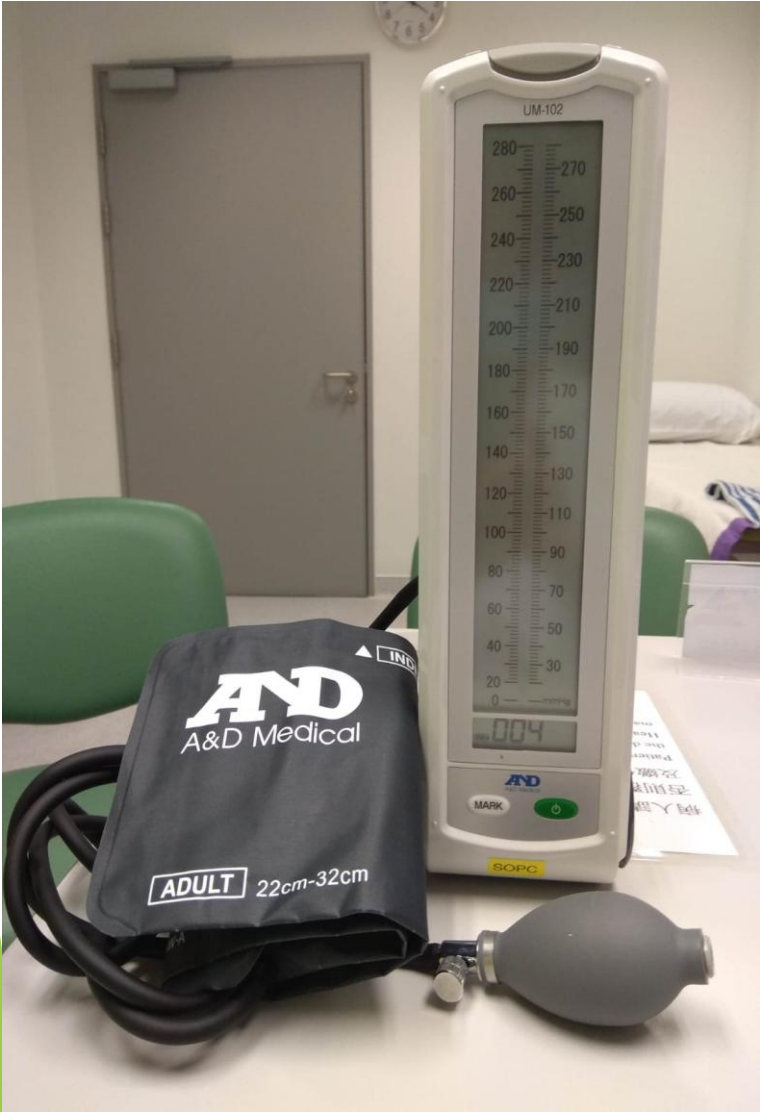
Based on
90th percentile
BP values
of children at
5th height
percentile

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Hypertension in Neonates and Infants

- ▶ BP normogram available for neonates of 26-44 weeks gestation to diagnose neonatal HT
- ▶ 2nd Task Force Report BP normogram for infants 1-12 months of age
- ▶ *Dionne JM et. Al. Hypertension in infancy: diagnosis, management and outcome. PediatrNephrol. 2012;27(1):17-32*
- ▶ *Report of the Second Task Force on Blood Pressure Control in Children-1987. Pediatrics. 1987;79:1-25*





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Implications for practice

- ▶ **Auscultatory** BP measurement for **confirmation**
- ▶ Use new screening BP table & normative BP tables
- ▶ 2017 normative BP a few mmHg lower than 2004



3. Change in the Frequency of Blood Pressure Measurement

Change in the Frequency of BP Measurement

- ▶ Begin BP measurement at age ≥ 3
- ▶ Only **annual** measurement is recommended unless risk factors are present
- ▶ BP should be checked in ≥ 3 years of age at every health visit if they have
 - ▶ **Obesity**
 - ▶ **Renal disease**
 - ▶ **On medications that increase BP**
 - ▶ **History of coarctation or diabetes**

TABLE 9 Conditions Under Which Children Younger Than 3 Years Should Have BP Measured

History of prematurity <32 week's gestation or small for gestational age, very low birth weight, other neonatal complications requiring intensive care, umbilical artery line

Congenital heart disease (repaired or unrepaired)

Recurrent urinary tract infections, hematuria, or proteinuria

Known renal disease or urologic malformations

Family history of congenital renal disease

Solid-organ transplant

Malignancy or bone marrow transplant

Treatment with drugs known to raise BP

Other systemic illnesses associated with HTN (neurofibromatosis, tuberous sclerosis, sickle cell disease,¹¹⁴ etc)

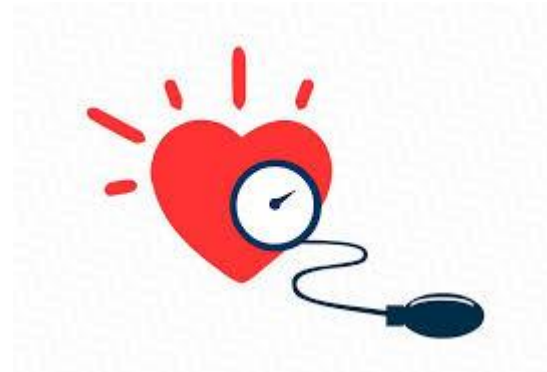
Evidence of elevated intracranial pressure

TABLE 8 Common Pharmacologic Agents Associated With Elevated BP in Children

Over-the-counter drugs	Decongestants Caffeine Nonsteroidal anti-inflammatory drugs Alternative therapies, herbal and nutritional supplements
Prescription drugs	Stimulants for attention-deficit/hyperactivity disorder Hormonal contraception Steroids Tricyclic antidepressants
Illicit drugs	Amphetamines Cocaine

Implications for practice

- ▶ **LESS** frequent BP measurement



4. Initial Management of Office Based Elevated Blood Pressure

Diagnosis of Hypertension

- ▶ **Auscultatory** confirmed blood pressure
 - ▶ ≥ 95 th percentile or
 - ▶ $\geq 130/80$ in adolescents ≥ 13 years of age in **3 different visits**



Initial Management of Office Based Elevated BP

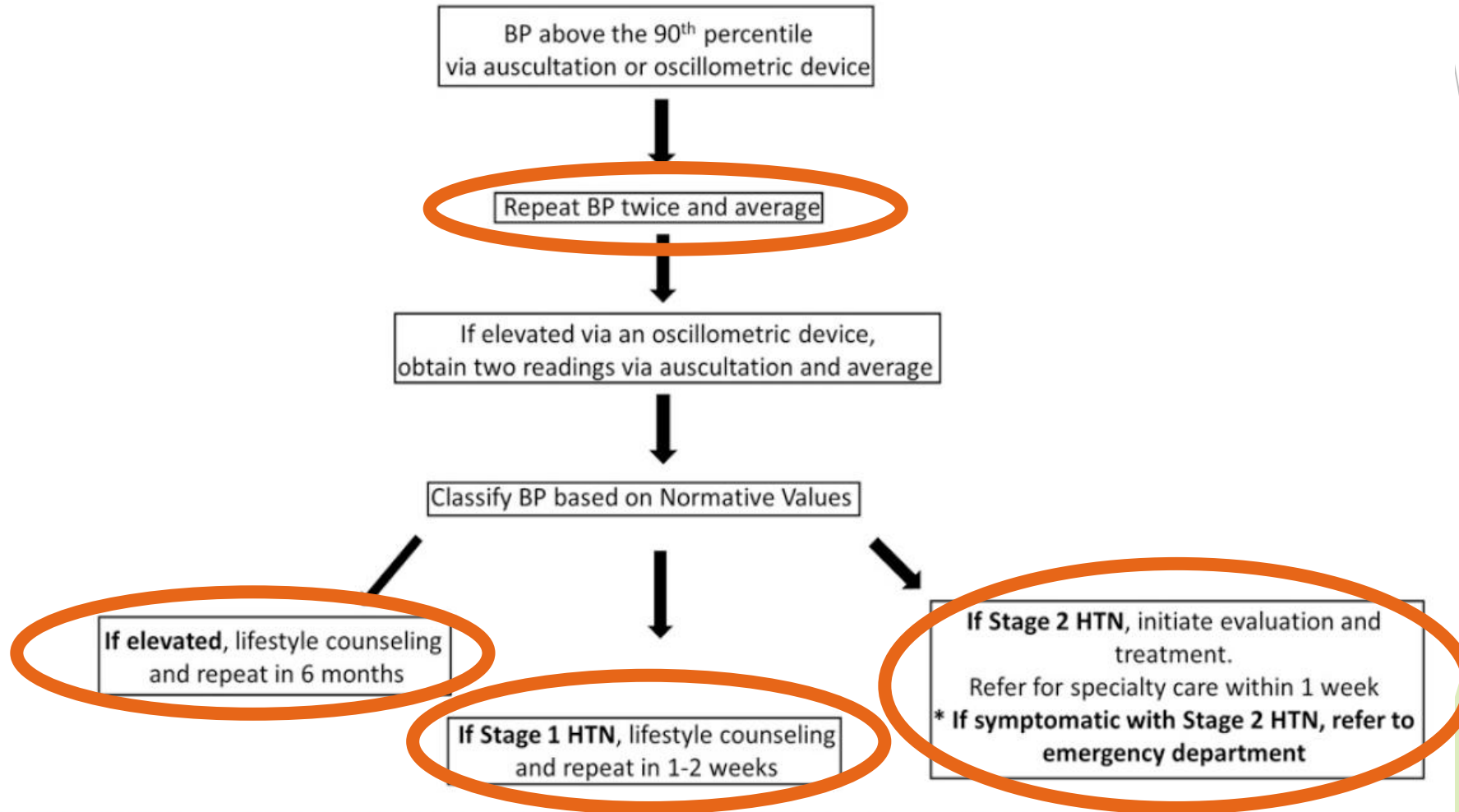


Figure 1. Algorithm for the evaluation of initial elevation in office-based blood pressures (BPs). HTN=hypertension.

Normal Blood Pressure

- ▶ < 90th percentile
- ▶ Lifestyle recommendations (nutrition, sleep, physical activity etc.)
- ▶ Recheck BP at next routine visit

Elevated Blood Pressure (≥ 90 percentile)

- ▶ If BP is elevated
- ▶ Lifestyle recommendations at each visit
- ▶ Recheck BP in **6 months**

- ▶ If BP is still elevated after **6 months**
- ▶ Check upper and lower limb BP
- ▶ Recheck BP in **6 months**

- ▶ If BP is still elevated after **12 months** (3 visits)
- ▶ ABPM (prior to diagnostic evaluation)
- ▶ Diagnostic evaluation
- ▶ Consider subspecialty referral

- ▶ If BP normalizes at subsequent visit
- ▶ Continue annual screening

Stage 1 Hypertension (≥ 95 percentile)

- ▶ If BP is Stage 1 HT and patient is **asymptomatic**
- ▶ Lifestyle recommendations at each visit
- ▶ Recheck BP in **1-2 weeks**
- ▶ If BP is still Stage 1 HT after **1-2 weeks**
- ▶ Check upper and lower limb BP
- ▶ Recheck BP in **3 months**
- ▶ If BP is still Stage 1 HT after **3 visits**
- ▶ **ABPM** (prior to diagnostic evaluation)
- ▶ **Diagnostic evaluation**
- ▶ **Consider subspecialty referral**
- ▶ **Initiate treatment** (primary care provider or subspecialist)

Stage 2 Hypertension (≥ 95 percentile + 12mmHg)

- ▶ If BP is Stage 2 HT and patient is **asymptomatic**
- ▶ Lifestyle recommendations at each visit
- ▶ Check upper and lower limb BP
- ▶ Recheck BP or refer to subspecialty care within **1 week**
- ▶ If BP is still Stage 2 HT after **1 week**
- ▶ ABPM (prior to diagnostic evaluation)
- ▶ Diagnostic evaluation
- ▶ Consider subspecialty referral within **1 week**
- ▶ Initiate treatment (primary care physician or subspecialist)

Stage 2 Hypertension

- ▶ If patient is **symptomatic** or
- ▶ BP is **>30 mm Hg above the 95th percentile** (or >180/120 in adolescent)
- ▶ ***Refer for emergency care !***

TABLE 11 Patient Evaluation and Management According to BP Level

BP Category (See Table 3)	BP Screening Schedule	Lifestyle Counseling (Weight and Nutrition)	Check Upper and Lower Extremity BP	ABPM ^a	Diagnostic Evaluation ^b	Initiate Treatment	Consider Subspecialty Referral
Normal Elevated BP	Annual	X	—	—	—	—	—
	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 6 mo	X	X	—	—	—	—
Stage 1 HTN	Third measurement: repeat in 6 mo	X	—	X	X	—	X
	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 1–2 wk	X	X	—	—	—	—
Stage 2 HTN ^d	Third measurement: repeat in 3 mo	X	—	X	X	X	X
	Initial measurement	X	X	—	—	—	—
	Second measurement: repeat, refer to specialty care within 1wk	X	—	X	X	X	X

Implications for practice

- ▶ Obtain multiple readings over time to diagnose hypertension
- ▶ **Office management** of hypertension

5. Expanded Use of Ambulatory Blood Pressure Monitoring (AMBP)

Expanded Use of ABPM

- ▶ Increase use of ABPM in children
- ▶ Normative data available based on age, sex and height (>120cm/> 5 yr)
- ▶ **Normal AMBP**
 - ▶ Mean SBP and DBP < 95th percentile
 - ▶ SBP and DBP load < 25%
- ▶ *Flynn JT, et al. Update: ambulatory blood pressure monitoring in children and adolescents: a scientific statement from the AHA. Hypertension. 2014;63(5):1116-1135*

Expanded Use of ABPM

- ▶ Diagnostic evaluation
- ▶ To confirm hypertension with elevated office BP measurements
 - ▶ With elevated BP for ≥ 1 year over **3 visits**
 - ▶ With Stage 1 HT over **3 visits**

Expanded Use of ABPM

- ▶ Use in **high-risk** groups: CKD, DM, coarctation, solid organ transplantation
- ▶ Evaluation of hypertension treatment
- ▶ Association with hypertensive target organ damage
- ▶ Diagnose **white coat hypertension (WCH)** and **masked hypertension (MH)**

TABLE 12 High-Risk Conditions for Which ABPM May Be Useful

Condition	Rationale
Secondary HTN	Severe ambulatory HTN or nocturnal HTN indicates higher likelihood of secondary HTN ^{161,167}
CKD or structural renal abnormalities	Evaluate for MH or nocturnal HTN, ^{168–172} better control delays progression of renal disease ¹⁷³
T1DM and T2DM	Evaluate for abnormal ABPM patterns, ^{174,175} better BP control delays the development of MA ^{176–178}
Solid-organ transplant	Evaluate for MH or nocturnal HTN, better control BP ^{179–188}
Obesity	Evaluate for WCH and MH ^{23,189–192}
OSAS	Evaluate for nondipping and accentuated morning BP surge ^{43,46,193,194}
Aortic coarctation (repaired)	Evaluate for sustained HTN and MH ^{58,112,113}
Genetic syndromes associated with HTN (neurofibromatosis, Turner syndrome, Williams syndrome, coarctation of the aorta)	HTN associated with increased arterial stiffness may only be manifest with activity during ABPM ^{58,195}
Treated hypertensive patients	Confirm 24-h BP control ¹⁵⁵
Patient born prematurely	Evaluate for nondipping ¹⁹⁶
Research, clinical trials	To reduce sample size ¹⁹⁷

Implications for practice

- ▶ Useful tool but machines may not be readily available
- ▶ No reference data for children with height < 120 cm/< 5yr
- ▶ **European** guidelines only recommend AMBP when considering antihypertensive medication

6. *A More Limited Diagnostic Evaluation*

TABLE 10 Screening Tests and Relevant Populations

Patient Population	Screening Tests
All patients	Urinalysis Chemistry panel, including electrolytes, blood urea nitrogen, and creatinine Lipid profile (fasting or nonfasting to include high-density lipoproteina and total cholesterol) Renal ultrasonography in those <6 y of age or those with abnormal urinalysis or renal function
In the obese (BMI >95th percentile) child or adolescent, in addition to the above	Hemoglobin A1c (accepted screen for diabetes) Aspartate transaminase and alanine transaminase (screen for fatty liver) Fasting lipid panel (screen for dyslipidemia) Fasting serum glucose for those at high risk for diabetes mellitus Thyroid-stimulating hormone Drug screen Sleep study (if loud snoring, daytime sleepiness, or reported history of apnea) Complete blood count, especially in those with growth delay or abnormal renal function

Optional tests to be obtained on the basis of history, physical examination, and initial studies



Adapted from Wiesen J, Adkins M, Fortune S, et al. Evaluation of pediatric patients with mild-to-moderate hypertension: yield of diagnostic testing. *Pediatrics*. 2008;122(5). Available at: www.pediatrics.org/cgi/content/full/122/5/e988.

TABLE 11 Patient Evaluation and Management According to BP Level

BP Category (See Table 3)	BP Screening Schedule	Lifestyle Counseling (Weight and Nutrition)	Check Upper and Lower Extremity BP	ABPM ^a	Diagnostic Evaluation ^b	Initiate Treatment ^c	Consider Subspecialty Referral
Normal Elevated BP	Annual	X	—	—	—	—	—
	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 6 mo	X	X	—	—	—	—
Stage 1 HTN	Third measurement: repeat in 6 mo	X	—	X	X	—	X
	Initial measurement	X	—	—	—	—	—
	Second measurement: repeat in 1–2 wk	X	X	—	—	—	—
Stage 2 HTN ^d	Third measurement: repeat in 3 mo	X	—	X	X	X	X
	Initial measurement	X	X	—	—	—	—
	Second measurement: repeat, refer to specialty care within 1 wk	X	—	X	X	X	X

Primary Hypertension

- ▶ Increase prevalence of primary HT
- ▶ Predominant cause of HT in **US** children
 - ▶ **≥ 6 yr** of age (**~ 10 yr** in Europe)
 - ▶ Positive family history of HT
 - ▶ Obesity, overweight
 - ▶ Systolic HT predictive of primary HT
 - ▶ Normal physical examination
- ▶ **Not require extensive evaluation for secondary causes**

Revised recommendations for echocardiography

- ▶ Prevalence of LVH ~30%-40% in Paediatric HT
- ▶ LVH increases CV risk independent of BP and BMI
- ▶ 2004: echocardiography at time of **diagnosis** of HT
- ▶ 2017: echocardiography at time of **starting pharmacologic treatment**
- ▶ Repeat echocardiography for patients with LVH or abnormal left ventricular function



Table 3 Recommended initial screening tests for the evaluation of pediatric hypertension

Children	European guidelines		US guidelines	
	All	Selected group	All	Selected group
Physical examination				
4 limb BP			X	
Laboratory evaluation				
Urea and creatinine	X		X	
Electrolytes	X		X	
Urinalysis	X		X	
Lipids	X (fasting)		X	(fasting in obesity)
Fasting glucose	X			X (high risk DM)
Urine culture	X			
Urine microalbumin	X			
Uric acid	X			
Hemoglobin A1c				X (obesity)
AST/ALT				X (obesity)
Imaging tests				
Renal ultrasound	X			X (children < 6 years or ≥ 6 years with concern for renal disease)
Echocardiography	X			X (at medication initiation)
24-h ABPM		X (at medication initiation or if clinical condition warrants)	X	

US United States, BP blood pressure, ABPM ambulatory blood pressure monitoring, AST aspartate transaminase, ALT alanine transaminase

Implications for practice

- ▶ **LESS** diagnostic evaluations including echocardiography
- ▶ **MISS secondary causes** of hypertension ? --> different prevalence of primary hypertension
- ▶ **European** guidelines recommends a more extensive initial evaluation for hypertensive children and adolescents

7. New Treatment Goals



New Treatment Goals

- ▶ For Primary HT or HT with DM
- ▶ **SBP and DBP to < 90th percentile** - target organ damage even in children with blood pressure between 90th and 95th percentile
- ▶ **< 130/80 mm Hg in adolescents ≥ 13 years of age**
- ▶ For CKD with HT, to lower AMBP mean arterial pressure **< 50th percentile**

Table 5 Hypertension treatment goals

	European guidelines		US guidelines	
	BP goal < 16 years	BP goal \geq 16 years	BP goal < 13 years	BP goal \geq 13 years
HTN without comorbidities	< 95th %ile	< 140/90	< 90th %ile*	< 130/80
HTN + diabetes mellitus type 1 or 2	< 90th %ile	< 130/80	< 90th %ile*	< 130/80
HTN + CKD				
-Without proteinuria	< 75th %ile	< 130/80	< 50th %ile MAP by ABPM	< 50th %ile MAP by ABPM
-With proteinuria	< 50th %ile	< 125/75	< 50th %ile MAP by ABPM	< 50th %ile MAP by ABPM

US United States, *BP* blood pressure, *CKD* chronic kidney disease, *MAP* mean arterial pressure, *ABPM* ambulatory blood pressure monitoring, *HTN* hypertension

*Or < 130/80, whichever lower

Lifestyle Interventions

- ▶ Dietary Approaches to Stop Hypertension (DASH)
- ▶ Moderate to vigorous physical activity at least 3 to 5 days per week (30-60 min per session)



Pharmacologic Treatment

- ▶ Pharmacological treatments if
 - ▶ **Failed at least 6 months** of lifestyle change
 - ▶ Symptomatic HT
 - ▶ Secondary HT
 - ▶ Stage 2 HT without clearly modifiable risk factor (e.g. obesity)
 - ▶ Any stage of HT with CKD or DM
- ▶ 1st line medications
 - ▶ ACE inhibitor or angiotensin receptor blocker (ARB)
 - ▶ Long-acting calcium channel blocker
 - ▶ Thiazide diuretic
 - ▶ In CKD or diabetes: ACE inhibitor or ARB

Follow Up

- ▶ On anti-HT medications
 - ▶ Reassess every 4-6 weeks for dose adjustments until goal BP is reached
 - ▶ Then every 3-4 months
- ▶ On lifestyle intervention
 - ▶ Reassess every 3-6 months for need of medications

Implications for practice

- ▶ **LOWER** treatment BP goals

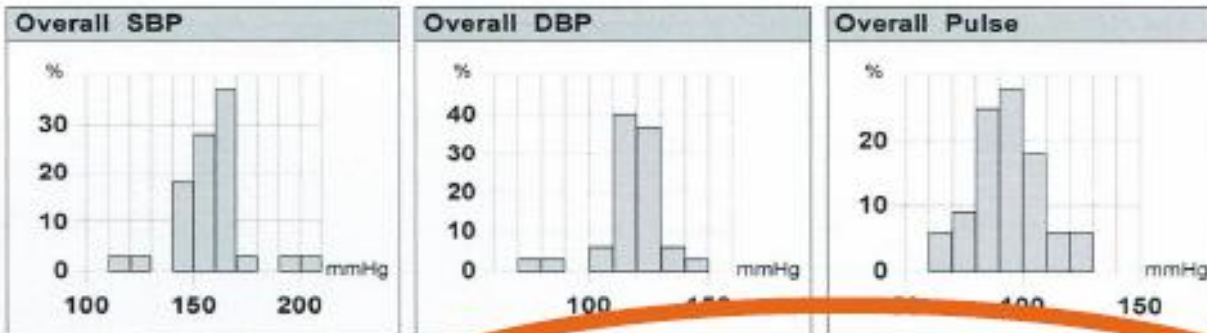
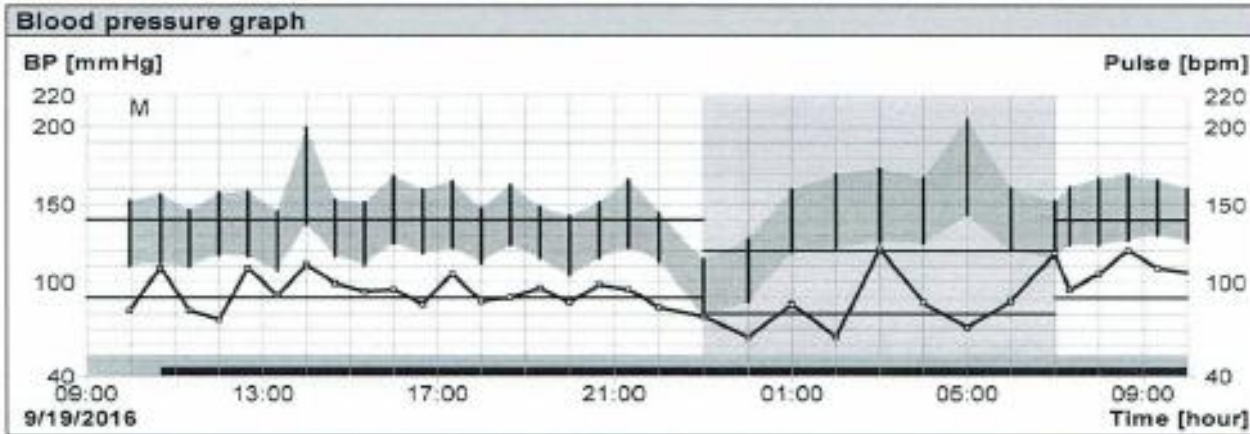
Case 1

- ▶ M/9
- ▶ ADHD on Ritalin, noted high BP and off
- ▶ No family history of early hypertension
- ▶ No symptoms
- ▶ Not obese, BW 25kg, HT 130cm
- ▶ BP 140/86, 135/85, 133/88 mmHg
- ▶ (95 percentile + 12 mmHg: 125/87 mmHg) : Stage 2 HT
- ▶ Physical Exam: NAD, no bruit
- ▶ Basic investigations: NAD
- ▶ AMBP...USG Kidney & Echo



PMH
ACC
AMBULATORY BP

Patient data			
name	[REDACTED]		
ID	[REDACTED]	birth date	6/2/2007



ABPM summary (9/19/2016 10:40 AM - 9/20/2016 10:40 AM)				
period	Overall	Morning	Day	Night
time range	Overall	07:00 - 07:00	07:00 - 23:00	23:00 - 07:00
SBP/DBP high limit	~130/85~	-/-	140/90	120/80
SBP/DBP weighted average	158/117	-/-	159/119	162/117
Pulse weighted average	99	-	97	-

Secondary HT
Renal
Cardiac
Endocrine

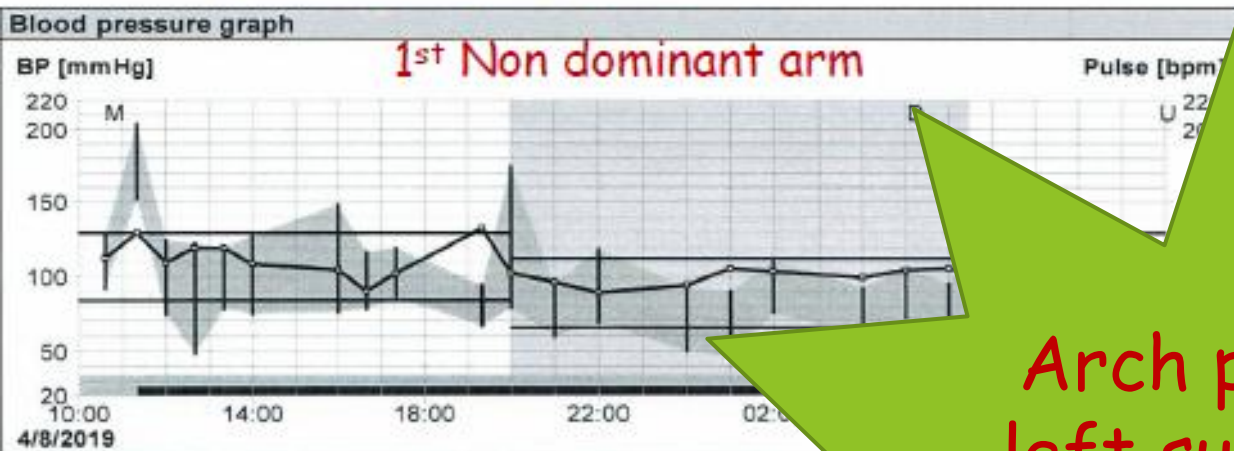
Dx:
Fibromuscular dysplasia
Renal artery stenosis

Case 2

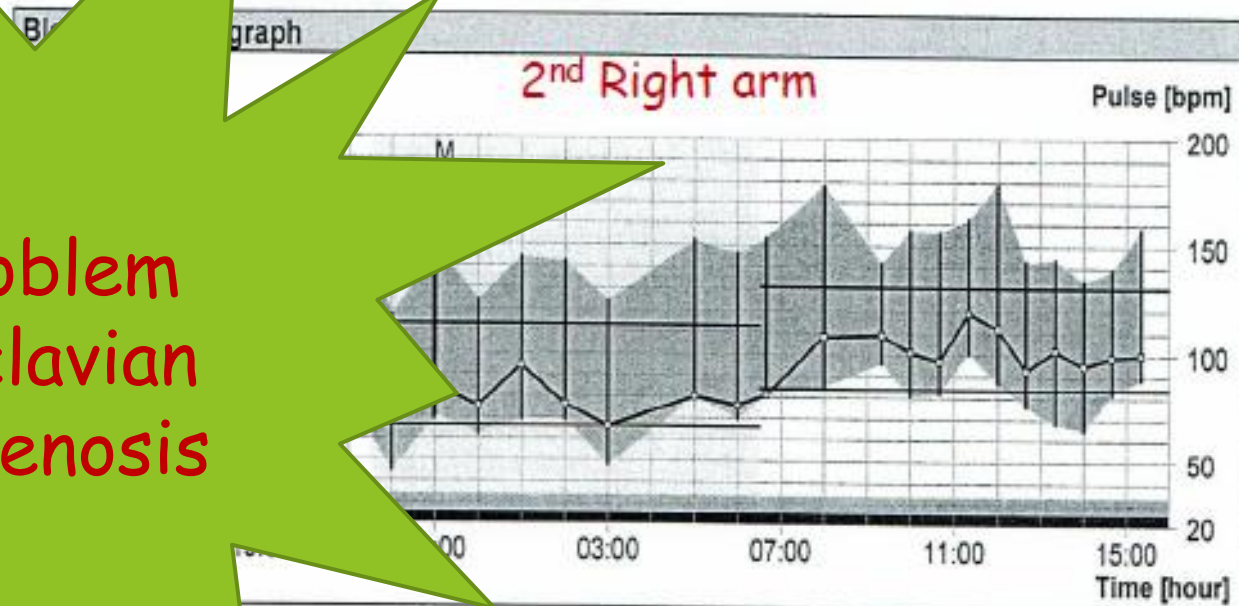
- ▶ F/12
- ▶ Obesity, mild OSAS
- ▶ Student Health Service BP: 158/78, 152/62, 134/56 mmHg
- ▶ No symptoms
- ▶ No family history of early hypertension
- ▶ Recheck BP in clinic: 148/72, 103/75 mmHg
- ▶ (95 percentile + 12 mmHg: 132/90 mmHg): Stage 2 HT
- ▶ Obese, HT 147 cm (75%), BW 58.6 kg (97%), BMI 27.1
- ▶ Physical Exam: soft ESM LUSB, acanthosis nigricans +
- ▶ Basic investigations: NAD
- ▶ ? Primary HT with obesity ?? WCH
- ▶ AMBP, Echo

Primary HT with Obesity
WCH
Secondary HT
Renal
Cardiac
Endocrine

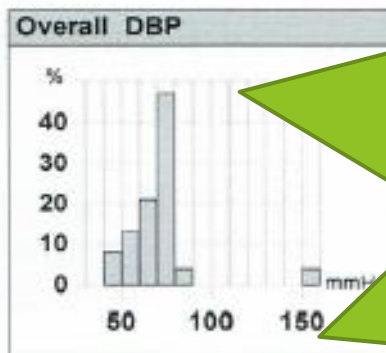
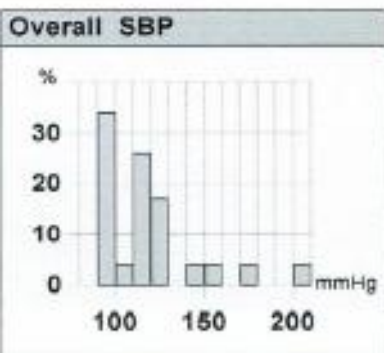
Patient data			
name	[REDACTED]		
ID	[REDACTED]	birth date	10/4/2007



Patient data			
name	[REDACTED]		
ID	[REDACTED]	birth date	10/4/2007



Arch problem
left subclavian
artery stenosis



ABPM summary (4/8/2019 11:20 AM - 4/9/2019 11:20 AM)

period	Overall	Morning	Day	Night
time range	Overall	06:30 - 06:30	06:30 - 21:30	21:30 - 06:30
SBP/DBP high limit	~120/75~	-/-	129/85	112/66
SBP/DBP weighted average	115/69	-/-	124/75	104/63
Pulse weighted average readings	105	-	110	99
Successfully ratio %	77	-	74	82
SBP/DBP D/N index %	16/17	-	-	-
morning surge	25	-	-	-

ABPM summary (11/19/2019 4:00 PM - 11/20/2019 4:00 PM)

period	Overall	Morning	Day	Night
time range	Overall	06:30 - 06:30	06:30 - 21:30	21:30 - 06:30
SBP/DBP high limit	~122/75~	-/-	131/84	113/66
SBP/DBP weighted average	148/76	-/-	155/82	138/65
Pulse weighted average readings	93	-	102	79
Successfully ratio %	88	-	87	90
SBP/DBP D/N index %	11/21	-	-	-
morning surge	27	-	-	-

Bring home messages

- ▶ Guidelines \neq Law
- ▶ Implement overseas guidelines with local adaptation
- ▶ Synergistic actions at various levels
 - ▶ Hospital
 - ▶ Community
- ▶ Stage 2/Secondary HT refer to specialists



References: Local normograms

- ▶ Sung RY, et al. Oscillometrically measured blood pressure in Hong Kong Chinese children and associations with anthropometric parameters. *J Hypertens* 2008; 26:678-684.
- ▶ Yip GW, et, al. Oscillometric 24-h ambulatory blood pressure reference values in Hong Kong Chinese children and adolescents. *J Hypertens* 2014; 32:606-619.

Thank you

