U.S. Department of Health and Human Services

National Institutes of Health

National Heart, Lung, and Blood Institute

National Heart, Lung, and Blood Institute
National High Blood Pressure Education Program

The 4th Report on High Blood Pressure in Children and Adolescents

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Introduction

- Purpose
  - To update clinicians on the latest scientific evidence regarding blood pressure in children
  - To provide recommendations for diagnosis, evaluation, and treatment of hypertension

Overview

- New national data have been added to the childhood BP database.
- Updated BP tables now include the 50th, 90th, 95th, and 99th percentiles by sex, age, and height.
- Hypertension in children and adolescents continues to be defined as systolic BP (SBP) and/or diastolic BP (DBP) that is, on repeated measurement, at or above the 95th percentile. BP between the 90th and 95th percentile is now termed “prehypertensive.”

Overview

- The rationale for identification of early target-organ damage in children and adolescents with hypertension is provided.
- Revised recommendations for use of antihypertensive drug therapy are provided.
- Treatment recommendations include nonpharmacologic therapies and reduction of other cardiovascular risk factors.
- Information is included on the identification of sleep disorders in some hypertensive children.

Methods

- The NHBPEP Coordinating Committee (CC) suggested updating the 1996 Working Group Report on Hypertension in Children and Adolescents.
- Prominent pediatric clinicians and scholars were selected to review available scientific evidence and submit manuscripts.
- The NHLBI Director appointed a working group to revise the report.

Methods

- Scientific evidence was classified in a process adapted from Last and Abramson (JNC 7).
- A draft was sent to the NHBPEP CC for review and vote.
- The report was published in the August 2004 supplement of *Pediatrics.*

Definition 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 to 120/80 mmHg should be considered prehypertensive.

Definition of Hypertension

- **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.)

Measurement of Blood Pressure in Children

- Children >3 years old should have their BP measured.
- Auscultation is the preferred method of BP measurement.
- Correct measurement requires a cuff that is appropriate to the size of the child's upper arm.
- Elevated BP must be confirmed on repeated measurement.
- BP >90th percentile obtained by oscillometric devices should be repeated by auscultation.

Conditions Under Which Children <3 Years Old Should Have BP Measured

- History of prematurity, very low birthweight, or other neonatal complication requiring intensive care
- Congenital heart disease, whether repaired or nonrepaired
- Recurrent urinary tract infections, hematuria, or proteinuria
- Known renal disease or urologic malformations
- Family history of congenital renal disease

Conditions Under Which Children <3 Years Old Should Have BP Measured

- Solid organ transplant
- Malignancy or bone marrow transplant
- Treatment with drugs known to raise BP
- Other systemic illnesses associated with hypertension
- Evidence of elevated intracranial pressure

Recommended Dimensions for Blood Pressure Cuff Bladders

Age Range	Width (cm)	Length (cm)	Maximum Arm Circumference (cm)*
Newborn	4	8	10
Infant	6	12	15
Child	9	18	22
Small adult	10	24	26
Adult	13	30	34
Large adult	16	38	44
Thigh	20	42	52

*Calculated so that the largest arm would still allow the bladder to encircle the arm by at least 80 percent.

Ambulatory Blood Pressure Monitoring

- Is useful in the evaluation of:
  - White-coat hypertension
  - Target-organ injury risk
  - Apparent drug resistance
  - Drug-induced hypotension.
- Provides additional BP information in:
  - Chronic kidney disease
  - Diabetes
  - Autonomic dysfunction.
- Should be performed by clinicians experienced in its use and interpretation.

Blood Pressure Tables

- BP standards based on sex, age, and height provide a precise classification of BP according to body size.

- The revised BP tables now include the 50th, 90th, 95th, and 99th percentiles by sex, age, and height.

Blood Pressure Levels for Boys by Age and Height Percentile

Age	BP	SBP (mmHg)							DBP (mmHg)						
		Percentile of Height							Percentile of Height						
(Year)	Percentile	5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90

Blood Pressure Levels for Girls by Age and Height Percentile

Age	BP	SBP (mmHg)							DBP (mmHg)						
		Percentile of Height							Percentile of Height						
(Year)	Percentile	5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91

How To Use the BP Tables

1. Use the standard height charts to determine the height 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).

How To Use the BP Tables

5. For SBP percentiles in the left columns and for DBP percentiles in the right columns:
   - **Normal BP** = <90th percentile.
   - **Prehypertension** = BP between the 90th and 95th percentile or ≥120/80 mmHg in adolescents.
   - **Hypertension** = BP >95th percentile on repeated measurement.

How To Use the BP Tables

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

Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	SBP or DBP Percentile
Normal	<90th percentile
Prehypertension	90th percentile to <95th percentile, or if BP exceeds 120/80 even if below the 90th percentile up to <95th percentile
Stage 1 hypertension	95th percentile to the 99th percentile plus 5 mmHg
Stage 2 hypertension	>99th percentile plus 5 mmHg

Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	Frequency of BP Measurement
Normal	Recheck at next scheduled physical examination.
Prehypertension	Recheck in 6 months.
Stage 1 hypertension	Recheck in 1–2 weeks or sooner if the patient is symptomatic; if BP is persistently elevated on two additional occasions, evaluate or refer to source of care within 1 month.
Stage 2 hypertension	Evaluate or refer to source of care within 1 week or immediately if the patient is symptomatic.

Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	Therapeutic Lifestyle Changes
Normal	Encourage healthy diet, sleep, and physical activity.
Prehypertension	Recommend weight management counseling if overweight; introduce physical activity and diet management.
Stage 1 hypertension	Recommend weight management counseling if overweight; introduce physical activity and diet management.
Stage 2 hypertension	Recommend weight management counseling if overweight; introduce physical activity and diet management.

Classification of Hypertension in Children and Adolescents, With Measurement Frequency and Therapy Recommendations

	Pharmacologic Therapy
Normal	None
Prehypertension	Do not initiate therapy unless there are compelling indications such as chronic kidney disease (CKD), diabetes mellitus, heart failure, left ventricular hypertrophy (LVH).
Stage 1 hypertension	Initiate therapy based on indications for antihypertensive drug therapy or if there are compelling indications as above.
Stage 2 hypertension	Initiate therapy.

Indications for Antihypertensive Drug Therapy in Children

- Symptomatic hypertension
- Secondary hypertension
- Hypertensive target-organ damage
- Diabetes (types 1 and 2)
- Persistent hypertension despite nonpharmacologic measures

Clinical Evaluation of Confirmed Hypertension

Study or Procedure	Purpose	Target Population
Evaluation for identifiable causes		
History, including sleep history, family history, risk factors, diet, and habits such as smoking and drinking alcohol; physical examination	History and physical examination help focus subsequent evaluation	All children with persistent BP ≥95th percentile
BUN, creatinine, electrolytes, urinalysis, urine culture	R/O renal disease and chronic pyelonephritis	All children with persistent BP ≥95th percentile
CBC	R/O anemia, consistent with chronic renal disease	All children with persistent BP ≥95th percentile
Renal ultrasound	R/O renal scar, congenital anomaly, or disparate renal size	All children with persistent BP ≥95th percentile

Clinical Evaluation of Confirmed Hypertension

Study or Procedure	Purpose	Target Population
Evaluation for comorbidity		
Fasting lipid panel, fasting glucose	To identify hyperlipidemia, identify metabolic abnormalities	Overweight patients with BP at 90th–94th percentiles; all patients with BP ≥95th percentile Family history of hypertension or cardiovascular disease Child with chronic renal disease
Drug screen	To identify substances that might cause hypertension	History suggestive of possible contribution by substances or drugs
Polysomnography	To identify sleep disorder in association with hypertension	History of loud, frequent snoring

Clinical Evaluation of Confirmed Hypertension

Study or Procedure	Purpose	Target Population
Evaluation for target-organ damage		
Echocardiogram	Identify LVH and other indications of cardiac involvement	Patients with comorbid risk factors* and BP at the 90th–94th percentiles; all patients with BP ≥95th percentile
Retinal examination	Identify retinal vascular changes	Patients with comorbid risk factors and BP at the 90th–94th percentiles; all patients with BP ≥95th percentile
Further evaluation as indicated		
Ambulatory BP monitoring	Identify white-coat hypertension, abnormal diurnal BP pattern, BP load	Patients in whom white-coat hypertension is suspected, and when other information on BP pattern is needed

*Comorbid risk factors also include diabetes mellitus and kidney disease

Clinical Evaluation of Confirmed Hypertension

Study or Procedure	Purpose	Target Population
Plasma renin determination	Identify low renin, suggesting mineralocorticoid-related disease	Young children with stage 1 hypertension and any child or adolescent with stage 2 hypertension Positive family history of severe hypertension
Renovascular imaging	Identify renovascular disease	Young children with stage 1 hypertension and any child or adolescent with stage 2 hypertension
Plasma and urine steroid levels	Identify steroid-mediated hypertension	Young children with stage 1 hypertension and any child or adolescent with stage 2 hypertension
Plasma and urine catecholamines	Identify catecholamine-mediated hypertension	Young children with stage 1 hypertension and any child or adolescent with stage 2 hypertension

Primary Hypertension and Evaluation for Comorbidities

- Primary hypertension is identifiable in children and adolescents.
- Hypertension and prehypertension are significant health issues in the young due to the marked increase in the prevalence of overweight children.
- The evaluation of hypertensive children should include assessment for additional risk factors.

Evaluation for Secondary Hypertension

- Secondary hypertension is more common in children than in adults.
- Body Mass Index (BMI) should be calculated as part of the physical examination.
- When hypertension is confirmed, BP should be measured in both arms and a leg.

Evaluation for Secondary Hypertension

- Children or adolescents with stage 2 hypertension, and very young children with stage 1 or stage 2 hypertension should be evaluated more completely.
- A comprehensive medical history should be obtained.
- History of drug and substance use should be included.

Evaluation for Secondary Hypertension

- A sleep history should be obtained. (There is an association of sleep apnea with overweight and high BP.)
- Family history should include history of hypertension and other cardiovascular disease.

Additional Diagnostic Studies for Hypertension

Renin Profiling

Plasma renin level or plasma renin activity (PRA) is a useful screening test for mineralocorticoid-related diseases.

Evaluation for Possible Renovascular Hypertension

Evaluation for renovascular disease also should be considered in infants or children with other known predisposing factors, such as prior umbilical artery catheter placements or neurofibromatosis.

Invasive Studies

Digital subtraction angiography and formal arteriography are still considered the “gold standard,” but these studies should be undertaken only when surgical or invasive interventional radiologic techniques are being contemplated for anatomic correction.

Target-Organ Abnormalities in Children with Hypertension

- Target-organ abnormalities are detectable in hypertensive children and adolescents.
- LVH is the most prominent evidence of target-organ damage.
- Echocardiographic assessment of left ventricular mass should be performed at diagnosis of hypertension and periodically thereafter.
- The presence of LVH is an indication to initiate or intensify antihypertensive therapy.

Clinical Recommendation

- Echocardiography is the recommended primary tool for detection of target-organ abnormalities.
- Children and adolescents with established hypertension should have an echocardiogram to determine if LVH is present.
- Echocardiographic measurements are used to calculate the left ventricular mass index.

Formula for Calculating Left Ventricular Mass

LV Mass (g) =

$$0.80\ [1.04\ (IVS + LVED + LVPW)^3 - (LVED)^3] + 0.6$$

Echocardiographic measurements are in cm.

Left Ventricular Hypertrophy

- Left ventricular mass is indexed by height in meters 2.7.
- A conservative cutpoint that defines LVH is 51 $g/m^{2.7}$.
- For patients who have LVH, the echocardiographic determination of the left ventricular mass index should be repeated periodically.

Therapeutic Lifestyle Changes

- Weight reduction is the primary therapy for obesity-related hypertension. Prevention of excess weight gain can limit future increases in BP.

- Physical activity can improve efforts at weight management and may prevent future increase in BP.

Therapeutic Lifestyle Changes

- Dietary modification should be strongly encouraged in children and adolescents with prehypertension, as well as those with hypertension.

- Family-based intervention improves success.

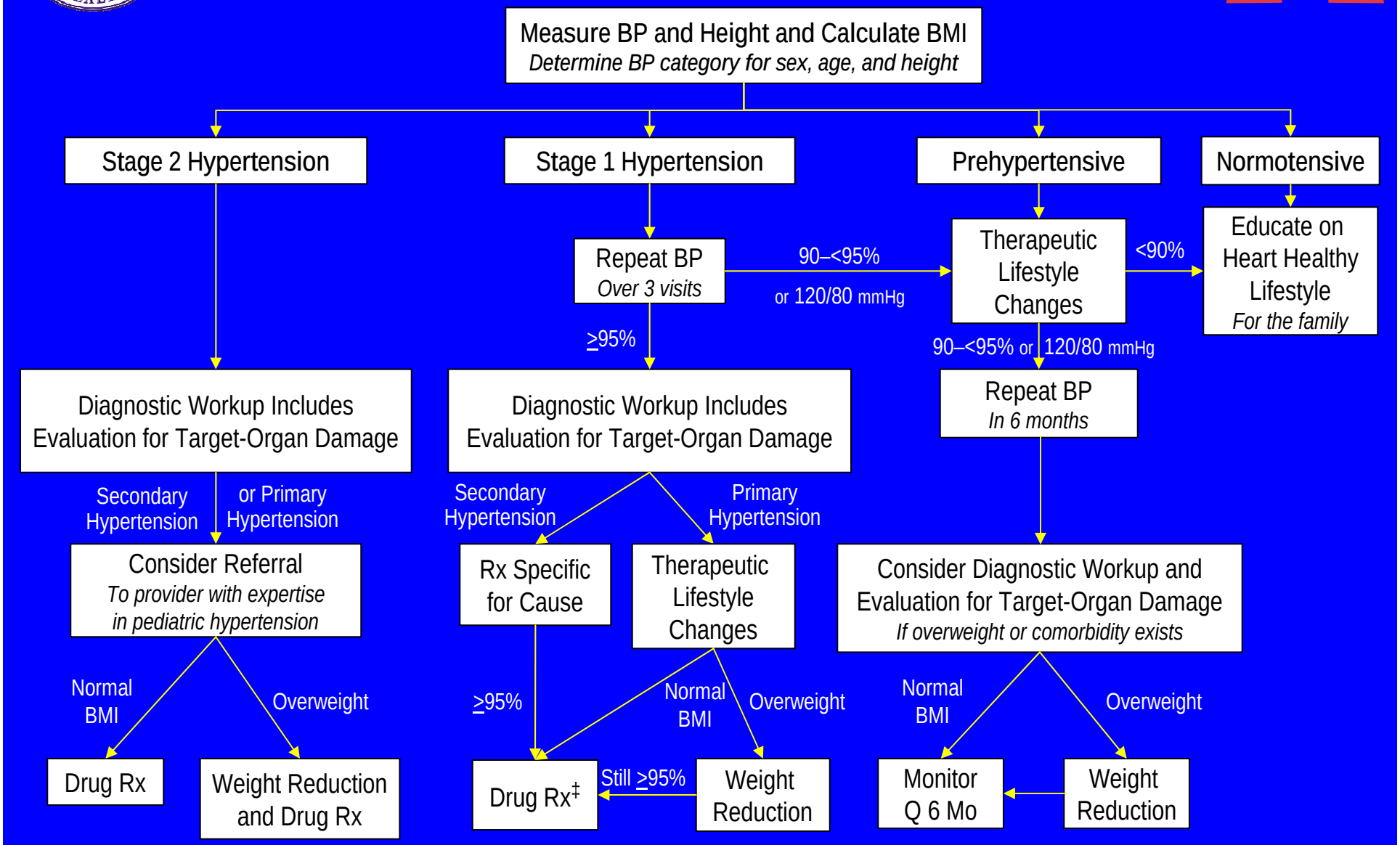
Pharmacologic Therapy for Childhood Hypertension

- Indications for antihypertensive drug therapy in children include secondary hypertension and insufficient response to lifestyle modifications.
- Recent clinical trials have expanded the number of drugs that have pediatric dosing information.
- Pharmacologic therapy should be initiated with a single drug.

Pharmacologic Therapy for Childhood Hypertension

- The goal for antihypertensive treatment in children should be reduction of BP to <95th percentile, unless concurrent conditions are present. In that case, BP should be lowered to <90th percentile.
- Severe, symptomatic hypertension should be treated with intravenous antihypertensive drugs.

Management Algorithm



Educational Materials

- Web Site www.nhlbi.nih.gov
- Pediatric Hypertension Clinical Reference Tool for Palm OS
- Complete Report
- Slide Show

Web Site
www.nhlbi.nih.gov

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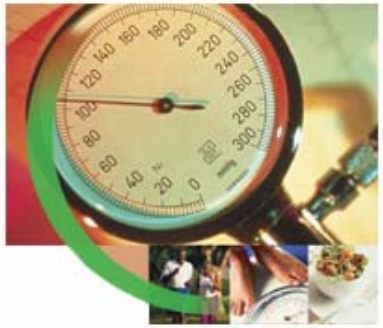
The Seventh Report of the Joint National Committee on

Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7)



The Guidelines

- JNC 7 Express
- JNC 7 Full Report--printed version
  - PubMed Abstract

Information for Patients

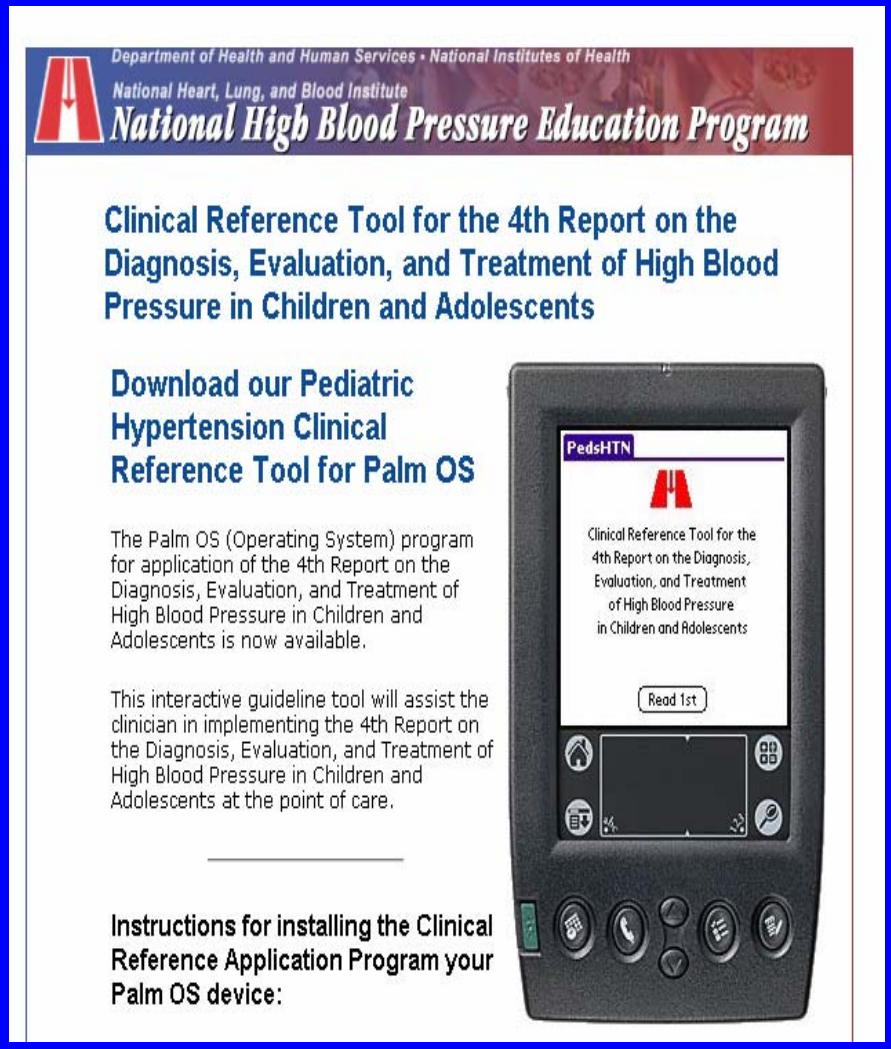
- My Blood Pressure Wallet Card
- Your Guide to Lowering Blood Pressure
- Facts About the DASH Eating Plan (revised, May 2003)

Information for Health Professionals

- 4th Report on High Blood Pressure in Children and Adolescents
- JNC 7 Application for **Palm OS** and **PocketPC**
- Physician Reference Card
- Slide Show

Clinical Reference Tool for Palm OS

- Interactive tool to assist the clinician in implementing the reports recommendations
- Available at: http://www.nhlbi.nih.gov



Complete Report

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