Hypertension Screening During Ambulatory Pediatric Visits in the United States, 2000–2009

WHAT'S KNOWN ON THIS SUBJECT: The American Academy of Pediatrics and National Heart, Lung, and Blood Institute recommend routine blood pressure measurement in children. Little is known about the frequency with which blood pressure is currently measured in ambulatory pediatric settings in the United States.

WHAT THIS STUDY ADDS: Between 2000 and 2009, providers measured blood pressure during only one-third of ambulatory pediatric visits and two-thirds of pediatric preventive visits. The current rate of screening is especially low for children aged 3 to 7 years.

abstract

FREE

BACKGROUND AND OBJECTIVE: Hypertension occurs in 2% to 5% of children in the United States, and its prevalence has increased during the obesity epidemic. There is no consensus among professional organizations about how frequently blood pressure should be measured in children >3 years old. The purpose of this study was to estimate the frequency of hypertension screening during ambulatory pediatric visits in the United States and to determine patient- and provider-level factors associated with screening during visits specifically for preventive care.

METHODS: We analyzed data from a nationally representative sample of ambulatory visits by using the National Ambulatory Medical Care Survey and the National Hospital Ambulatory Medical Care Survey from 2000 through 2009. In the subset of visits involving patients aged 3 to 18 years, we estimated the frequency of screening during all visits, preventive visits, and preventive visits in which overweight/obesity was diagnosed. We used multivariable logistic regression to identify patient- and provider-level factors associated with screening.

RESULTS: Hypertension screening occurred during 35% of ambulatory pediatric visits, 67% of preventive visits, and 84% of preventive visits in which overweight/obesity was diagnosed. Between 2000 and 2009, the frequency of screening increased in all visits and in preventive visits. Factors independently associated with screening included older age and overweight/obesity diagnosis.

CONCLUSIONS: Providers do not measure blood pressure in two-thirds of pediatric visits and one-third of pediatric preventive visits. Providers may understand the importance of screening among overweight/obese children; however, efforts to encourage routine screening, particularly in young children, may be needed. *Pediatrics* 2012;130:604–610

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KEY WORDS
blood pressure, hypertension, screening

ABBREVIATIONS
CI—confidence interval
EMR—electronic medical record
NAMCS—National Ambulatory Medical Care Survey
NCHS—National Center for Health Statistics
NHLBI—National Heart, Lung, and Blood Institute
NHAMCS—National Hospital Ambulatory Medical Care Survey
OR—odds ratio
PSU—primary sampling unit

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Hypertension occurs in 2% to 5% of children in the United States, and its prevalence has increased in recent years.[1–4] The growing prevalence of obesity, physical inactivity, and more frequent intake of foods high in calories and salt are contributing to this trend.[5,6] Pediatric hypertension can be associated with primary renal parenchymal disease, may be a sign of an underlying pathologic condition (eg, coarctation of the aorta, renal artery stenosis), usually persists into adulthood, and is a risk factor for cardiovascular disease and end organ damage (eg, left ventricular hypertrophy)[7–13]; thus, early diagnosis of hypertension in children and adolescents is of paramount importance. Measurement of blood pressure is a cost-effective, noninvasive, and relatively accurate method to identify pediatric hypertension.[14] Because many patients in the United States have limited access to health care resources and may visit medical settings infrequently, ambulatory visits represent an important opportunity to screen for pediatric hypertension.

There is no consensus among professional organizations about how frequently blood pressure should be measured in children. The National Heart, Lung, and Blood Institute (NHLBI) recommended in 2004 that medical providers assess blood pressure in children aged >3 years at every medical encounter[14]; however, in 2011 an NHLBI task force published an evidence report, endorsed by the American Academy of Pediatrics, that recommended annual blood pressure measurement in children >3 years old.[15] Bright Futures, a national health care promotion initiative, recommends blood pressure measurement during all health supervision visits by children >5 years,[15] while the United States Preventive Services Task Force does not endorse a specific recommendation because of inconclusive evidence.[16]

In several regional surveys, >90% of physicians have reported that they routinely measured blood pressure in preventive care visits.[17–20] However, the only national study of blood pressure measurement in the United States, conducted between 1985 and 1996, estimated that providers performed screening in only 50% to 60% of preventive visits.[21] The frequency with which physicians currently perform screening in ambulatory pediatrics in the United States is unknown.

This study had 2 objectives. First, we estimated the frequency of hypertension screening in a nationally representative sample of visits in ambulatory pediatric settings. Second, in the subset of visits specifically for preventive care, we identified characteristics of patients and providers that were associated with screening.

METHODS

Data Source and Design

We analyzed data from the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) to estimate the frequency of hypertension screening in children during ambulatory visits in the United States. We combined data collected in the surveys between 2000 and 2009, the 10 most recent years of available data. The National Center for Health Statistics (NCHS) administers the NAMCS and NHAMCS annually at a nationally representative sample of visits to offices, outpatient departments, and emergency departments in the United States. The surveys are used to collect information about patient demographics, diagnoses (by using codes from the *International Classification of Diseases, Ninth Revision, Clinical Modification*), medications prescribed, and procedures performed.

The NCHS uses a 3-stage probability sampling procedure to administer the NAMCS during office visits. The NCHS samples 112 geographic primary sampling units (PSUs), physician practices within PSUs, and visits within practices. Likewise, the NCHS administers the NHAMCS during visits to hospital outpatient departments and emergency departments by using a 4-stage sampling procedure. The NCHS samples geographic PSUs, hospitals within PSUs, clinics and emergency service areas within hospitals, and visits within clinics and emergency service areas. For each visit, the NCHS provides a visit weight equal to the inverse probability of that visit being sampled. These weights allow for the generation of nationally representative estimates by using data from the NAMCS and NHAMCS. In this study, we analyzed data from visits to offices and hospital outpatient departments, and we excluded data from visits to emergency departments.

Study Population

We defined the study population to include all sampled visits by patients aged 3 to 18 years to offices or outpatient departments in the United States between 2000 and 2009 (N = 93 534 sampled visits). Hypertension screening was defined as having occurred if the physician recorded on the survey instrument that blood pressure had been measured. In addition to this overall analysis, which included visits for preventive, acute, and chronic care, we estimated the frequency of screening in 2 subsets of visits: (1) visits for preventive care (N = 15 334) and (2) preventive visits in which the patient was diagnosed as overweight or obese (N = 705). Surveyed providers distinguished visits for preventive care from those for acute or chronic care by using a check box on the survey instrument that denoted the "major reason for the visit." Providers diagnosed overweight/obesity by either

checking a box for "obesity" on the survey instrument or assigning a diagnosis of overweight or obesity (International Classification of Diseases codes 278.00–278.02) in any of 3 diagnosis fields. We hypothesized that the frequency of hypertension screening would be higher in preventive visits than in all pediatric visits because obtaining blood pressure is a part of routine preventive care but might not occur at some pediatric visits (eg, those for acute or urgent care). Additionally, we hypothesized that the frequency of hypertension screening would be highest in preventive visits in which overweight/obesity was diagnosed because providers who identified overweight/obesity might have a heightened concern for hypertension in this vulnerable patient population.

Because some overweight or obese patients may not have received a diagnosis of overweight or obesity, we also estimated the frequency of hypertension screening in patients who were clinically overweight/obese. We defined a patient to be clinically overweight/obese if BMI was at or above the 85th percentile for age and gender.[22] This analysis was conducted for visits that occurred between 2005 and 2009, the only years in which height and weight were recorded on the survey instrument.

Analysis

Our main outcomes in this study were the number and percentage of ambulatory pediatric visits in which hypertension screening occurred between 2000 and 2009. We estimated the frequency of screening in all visits, preventive visits, and preventive visits in which overweight or obesity was diagnosed. We grouped data into 2-year intervals and used logistic regression to determine whether there was a time trend in the frequency of screening at any of these visit types.

In the subset of visits specifically for preventive care, we used multivariable logistic regression to assess whether characteristics of patients (age, gender, race/ethnicity, insurance type, overweight/obesity diagnosis) or providers (clinical setting, length of visit, US Census region, practice setting, use of electronic medical records [EMRs]) were associated with hypertension screening. We chose to limit this analysis to visits for preventive care because we feel that obtaining blood pressure is part of routine preventive care (eg, well checks), whereas we acknowledge that screening might not occur at all types of visits (eg, urgent care visits for sore throat or a sprained ankle). A χ^2 test was used to determine which variables were nominally ($P < .2$) associated with hypertension screening. Variables that were nominally associated with screening were included in the multivariable model. A variable for physician specialty (pediatric primary care, family practice, internal medicine, specialists) was included in a model that used data from offices only (NAMCS). To distinguish pediatric subspecialists from general pediatricians, we used a variable that denoted whether the physician considered himself or herself as the primary care provider for the patient. The "specialist" category, therefore, included physicians who were not classified as family medicine physicians, internists, or pediatricians who considered themselves the patient's primary care provider.

In the subset of preventive visits that occurred between 2005 and 2009 and in which height and weight were measured, we estimated the frequency of hypertension screening in patients who were clinically overweight/obese. We used a χ^2 test to determine whether these patients were screened more frequently than patients who were not clinically overweight/obese. For the same survey years, we estimated the frequency with which height was measured given that blood pressure was measured at preventive visits. We performed this analysis to determine a ceiling on the frequency with which true hypertension screening could have occurred because a record of the patient's height is required to interpret blood pressure values adequately.

All analyses were conducted by using Stata 11 software (Stata Corp, College Station, TX) and took into account components of the survey design.

RESULTS

Frequency of Hypertension Screening

During the 10-year study period, there were 93 534 ambulatory visits by children 3 to 18 years old that were sampled in the NAMCS and NHAMCS. When survey weights were applied, these 93 534 sampled visits represented an average of 142 million (95% confidence interval [CI]: 131–153 million) ambulatory visits per year for children aged 3 to 18 years. Hypertension screening occurred during 35% (95% CI: 34%–36%) of these visits, and the frequency of screening increased significantly during the study period, from 26% (95% CI: 23%–28%) in 2000–2001 to 41% (95% CI: 38%–44%) in 2008–2009 ($P < .0001$; Fig 1). On average, 28 million (95% CI: 25–30 million) pediatric visits per year, that is, 20% of all pediatric visits, were for preventive care; hypertension screening occurred during 67% (95% CI: 65% to 69%) of preventive visits. There was an increase in the frequency of screening at preventive visits during the study period, from 51% (95% CI: 45%–56%) in 2000–2001 to 71% (95% CI: 67%–75%) in 2008–2009 ($P < .0001$). Hypertension screening occurred during 84% (95% CI: 78%–89%) of preventive visits in which children were diagnosed as overweight/obese. This frequency did

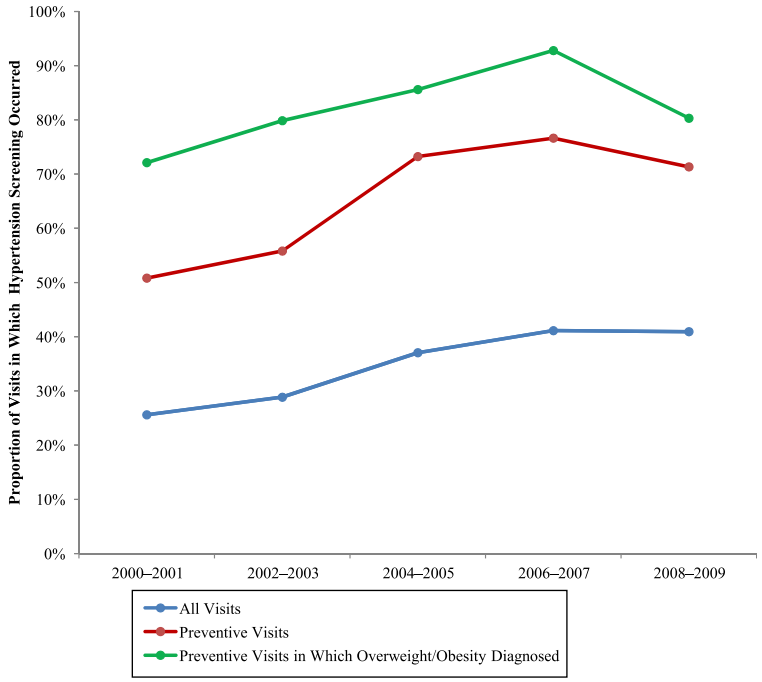

FIGURE 1
Frequency of hypertension screening in all pediatric visits, pediatric preventive visits, and pediatric preventive visits in which overweight/obesity was diagnosed, 2000–2009.

not change significantly during the study period (P = .68).

In the subset of preventive visits that occurred between 2005 and 2009 (the only years in which height and weight were recorded on the survey instruments), 44% (95% CI: 42%–46%) of patients were overweight/obese based on BMI values. Hypertension screening occurred in 84% (95% CI: 81%–86%) of these visits. Among patients whose height and weight were measured, there was no difference in the frequency of screening between those who were clinically overweight or obese (84%) and those who were not overweight or obese (84%; P = .88). Height was measured in 89% (95% CI: 87%–90%) of preventive visits in which blood pressure was measured.

Factors Associated With Hypertension Screening

Table 1 shows characteristics of patients and providers that were independently associated with hypertension screening at pediatric preventive visits. Screening was more likely among older children (odds ratio [OR] 2.6, 95% CI: 2.2–3.0 for 13- to 18-year-olds; OR 1.5, 95% CI: 1.3–1.8 for 8- to 12-year-olds) compared with 3- to 7-year-olds, during visits lasting >15 minutes (OR 1.3, 95% CI: 1.1–1.7), and among children diagnosed as overweight or obese (OR 2.2, 95% CI: 1.4–3.5). In a subanalysis of data from visits to offices only, specialists were less likely than pediatric primary care physicians to screen for hypertension during preventive visits (OR 0.4, 95% CI: 0.3–0.5). Gender, race/ethnicity, US Census region, practice setting, and use of EMRs were not independently associated with hypertension screening in multivariable analysis.

DISCUSSION

Our analysis of national ambulatory survey data found that hypertension screening occurred during only one-third of pediatric visits and during only two-thirds of pediatric preventive visits in the United States between 2000 and 2009. The rate of hypertension screening was especially low for children aged 3- to 7 years. However, the frequency of hypertension screening during all visits and preventive visits increased significantly during the study period.

Hypertension screening is particularly important in overweight/obese children. We found a relatively high frequency of screening (84%) among children who were diagnosed as overweight/obese, which suggests that practitioners may recognize the increased risk of hypertension in this vulnerable population. However, it is potentially concerning that blood pressure was not measured in nearly 1 of 5 of these children. Although specific circumstances at some visits may have rendered blood pressure measurement impractical or unfeasible, we were unable to determine from our data why blood pressure was not measured at 16% of these visits. Several studies suggest that overweight/obese children have an elevated risk of hypertension,[23–26] and our finding suggests that most physicians who diagnose overweight/obesity also recognize the importance of screening these patients.

We found no association between clinical overweight/obesity and the frequency of hypertension screening in patients whose height and weight were measured. This finding may be explained by the positive correlation between measurement of height and weight and measurement of blood pressure. In other words, providers who measured height and weight also measured blood pressure in the vast majority (84%) of preventive visits, regardless of their weight status. This may occur because the interpretation of blood pressure requires anthropometric data and/or because these measurements occur sequentially during many ambulatory visits.

Although a previous national study found racial and ethnic disparities in the

TABLE 1 Patient-, Provider-, and Practice-Level Factors Associated With Hypertension Screening in Pediatric Preventive Visits

Characteristic	No. of Sampled Preventive Visits (N = 15 334)	Weighted Proportion of Visits With Hypertension Screening, %	P (χ^2)	OR (95% CI) for Hypertension Screening
Time, per 2 y		—	<.0001	1.3 (1.2–1.4)
Age group, y			<.0001	
3–7	5353	56		1.00
8–12	3463	67		1.5 (1.3–1.8)
13–18	6518	77		2.6 (2.2–3.0)
Gender			.01	
Male	7508	65		1.00
Female	7826	68		1.0 (0.9–1.2)
Race/ethinicity[a]			.53	
Non-Hispanic white	6343	69		1.00
Non-Hispanic black	3635	69		0.9 (0.7–1.2)
Hispanic	3668	66		0.9 (0.7–1.2)
Other	1043	66		1.0 (0.7–1.4)
US census region			.03	
Northeast	5,5.2	68		1.00
Midwest	3720	70		1.1 (0.8–1.4)
South	3294	67		0.9 (0.7–1.2)
West	2818	61		0.8 (0.5–1.0)
Specialty[b]			<.0001	
Pediatric preventive care	3653	67		1.00
Family practice	1078	75		1.1 (0.8–1.5)
Internal medicine	84	69		0.7 (0.4–1.3)
Specialists	1645	59		0.4 (0.3–0.5)
Setting			.11	
Physician office	6460	67		1.00
Outpatient department	8874	70		1.1 (0.9–1.3)
Overweight/obesity diagnosed?			<.0001	
No	14 629	66		1.00
Yes	705	84		2.2 (1.4–3.5)
Length of visit, min[b]			<.0001	
≤15	3263	63		1.00
>15	3358	70		1.3 (1.0–1.7)
EMR[b,c]			.02	
No	2502	76		1.00
Yes	2351	70		0.8 (0.6–1.1)
Insurance type[a]			.63	
Nonprivate	8798	67		
Private	5790	66		
Metropolitan statistical area			.83	
Metropolitan	13 640	68		
Nonmetropolitan	1016	68		

[a] Raw N do not sum to 15 334 because of missing data.
[b] Data are for NAMCS (offices) only. ORs are estimated from a separate model by using data only from the NAMCS surveys.
[c] Data were available only for 2003–2009.

frequency of screening for hypertension,[21] our study found no significant differences in the frequency of screening by race or ethnicity. This may be explained by the fact that we controlled for the diagnosis of overweight or obesity, whereas the previous study did not. Alternatively, our results may reflect a time trend toward more equal screening by race and ethnicity, which is consistent with recommendations from national guidelines.[14] Because there is limited evidence of racial or ethnic differences in the risk of hypertension in children,[27,28] it may not be necessary for physicians to consider race or ethnicity as a predisposing factor for pediatric hypertension.

We also found that providers were significantly more likely to screen older children than younger children, even after controlling for physician specialty. This finding is similar to the results found in the earlier national study regarding hypertension screening[21] as well as several studies examining screening trends for overweight/obesity and related complications.[29,30] This may be due to a perception that older children are more likely to cooperate (eg, not cry or fuss) during blood pressure measurement; because of a heightened concern for early presentation of adult cardiovascular disease in older children; because some offices lack an appropriately sized cuff; or because providers underestimate the prevalence of hypertension, and thus the importance of screening, in younger patients. Still, screening younger children could unveil secondary causes of hypertension. Younger children with hypertension are more likely to have underlying pathology and secondary causes for their elevated blood pressures, which underscores the importance of screening in this age group. The fact that nearly 50% of children aged 3 to 7 years do not have blood pressure screening performed at preventive visits is concerning.

We found no independent association between use of EMR and hypertension screening at preventive visits, even though use of health information technology has been associated with improved adherence to preventive health guidelines.[31] Use of clinical decision support tools in conjunction with EMR has been associated with improved blood pressure control[32]; however, 2 previous national studies using the NAMCS and NHAMCS surveys found no impact of EMR use alone on several quality indicators.[33,34] There may be a role for EMR to encourage guideline-recommended practices for hypertension screening (for example, by reminding practitioners to record blood pressure whenever a value is not

entered in the EMR) but additional data to support the specific role of EMR are needed.

We acknowledge several limitations to this study. First, it is possible that in some cases physicians measured blood pressure without recording it on the survey instrument. This would have led us to underreport the true frequency of hypertension screening. Second, although we were able to estimate the national frequency of hypertension screening and examine variation thereof, it was not possible to determine the appropriateness of screening at any specific visit. We acknowledge that specific circumstances at certain visits may have rendered measurement of blood pressure unnecessary or inappropriate. Indeed, national guidelines for hypertension screening provide recommendations for routine care; an evaluation of the quality of care at any specific visit in our data set is both beyond the scope of our analysis and inconsistent with the purpose of guidelines. Third, because the unit of observation in our study was the visit rather than the patient, it was not possible to determine what percentage of pediatric patients had their blood pressure measured annually. To the extent that physicians follow the NHLBI recommendation to screen patients annually, it may be that some patient groups in our study (eg, young children) had their blood pressure measured less frequently simply because they sought care more frequently than other patient groups. Fourth, we defined hypertension screening based on the reporting of a blood pressure measurement, and we were unable to comment on the adequacy of measurement or the interpretation of specific blood pressure values. Several studies have documented a systematic underrecognition of pediatric hypertension, even when blood pressure is measured.[35–37] The high frequency (89%) of height measurement in patients whose blood pressure was measured suggests that screening could have occurred at most preventive visits. However, in at least 11% of preventive visits in which blood pressure was measured, blood pressure values could not have been interpreted appropriately. Contemporaneous measurement of height and blood pressure, together with appropriate use of blood pressure tables, is required for providers to screen appropriately for hypertension in children. Finally, it is possible that visits made by the same patient could have been sampled more than once during the study period. Because data in the NAMCS and NHAMCS are collected during short periods (1 week and 4 weeks, respectively) and because different offices and hospitals can be selected during different survey years, it is highly unlikely that patients revisited offices or outpatient departments to an extent that would have significantly influenced our results.

Our study is the first in more than a decade to estimate the frequency of hypertension screening nationally. Similar to an earlier study, we found that physicians likely overestimate the extent to which they routinely measure blood pressure. In addition, although there has been a significant increase in the frequency of blood pressure measurement in recent years, many children, especially those aged 3 to 7 years, do not have their blood pressure measured during preventive visits. Given the growing prevalence of obesity and the known long-term ramifications associated with pediatric hypertension, efforts to encourage routine screening at primary care visits, particularly in younger children, may be needed.

REFERENCES

1. Sinaiko AR, Gomez-Marin O, Prineas RJ. Prevalence of "significant" hypertension in junior high school–aged children: the Children and Adolescent Blood Pressure Program. *J Pediatr*. 1989;114(4 pt 1):664–669
2. Muntner P, He J, Cutler JA, Wildman RP, Whelton PK. Trends in blood pressure among children and adolescents. *JAMA*. 2004;291(17):2107–2113
3. Sorof JM. Prevalence and consequence of systolic hypertension in children. *Am J Hypertens*. 2002;15(2 pt 2):57S–60S
4. McNiece KL, Poffenbarger TS, Turner JL, Franco KD, Sorof JM, Portman RJ. Prevalence of hypertension and pre-hypertension among adolescents. *J Pediatr*. 2007;150(6):640–644
5. Mitsnefes MM. Hypertension in children and adolescents. *Pediatr Clin North Am*. 2006;53(3):493–512, viii
6. Sugiyama T, Xie D, Graham-Maar RC, Inoue K, Kobayashi Y, Stettler N. Dietary and lifestyle factors associated with blood pressure among U.S. adolescents. *J Adolesc Health*. 2007;40(2):166–172
7. Berenson GS, Srinivasan SR, Bao W, Newman WP III, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. *N Engl J Med*. 1998;338(23):1650–1656
8. Lauer RM, Clarke WR. Childhood risk factors for high adult blood pressure: the Muscatine Study. *Pediatrics*. 1989;84(4):633–641
9. Sun SS, Grave GD, Siervogel RM, Pickoff AA, Arslanian SS, Daniels SR. Systolic blood pressure in childhood predicts hypertension and metabolic syndrome later in life. *Pediatrics*. 2007;119(2):237–246
10. Bao W, Threefoot SA, Srinivasan SR, Berenson GS. Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: the Bogalusa Heart Study. *Am J Hypertens*. 1995;8(7):657–665
11. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. *Circulation*. 2008;117(25):3171–3180
12. Sorof JM, Alexandrov AV, Cardwell G, Portman RJ. Carotid artery intimal-medial thickness and left ventricular hypertrophy in children with elevated blood pressure. *Pediatrics*. 2003;111(1):61–66
13. Daniels SR, Loggie JM, Khoury P, Kimball TR. Left ventricular geometry and severe left

ventricular hypertrophy in children and adolescents with essential hypertension. *Circulation*. 1998;97(19):1907–1911

14. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004; 114(suppl 2 4th report):555–576
15. Hagan JFSJ, Duncan PM, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics; 2008
16. US Preventive Services Task Force. Screening for high blood pressure: recommendations and rationale. *Am Fam Physician*. 2003;68 (10):2019–2022
17. Ellen JM, Franzgrote M, Irwin CE Jr, Millstein SG. Primary care physicians' screening of adolescent patients: a survey of California physicians. *J Adolesc Health*. 1998;22(6):433–438
18. Kimm SY, Payne GH, Stylianou MP, Waclawiw MA, Lichtenstein C. National trends in the management of cardiovascular disease risk factors in children: second NHLBI survey of primary care physicians. *Pediatrics*. 1998;102(5). Available at: www.pediatrics.org/cgi/content/full/102/5/e50
19. Boneparth A, Flynn JT. Evaluation and treatment of hypertension in general pediatric practice. *Clin Pediatr (Phila)*. 2009;48(1):44–49
20. Kimm SY, Payne GH, Lakatos E, Darby C, Sparrow A. Management of cardiovascular disease risk factors in children. A national survey of primary care physicians. *Am J Dis Child*. 1990;144(9):967–972
21. Moran CM, Panzarino VM, Darden PM, Reigart JR. Preventive services: blood pressure checks at well child visits. *Clin Pediatr (Phila)*. 2003;42(7):627–634
22. Centers for Disease Control and Prevention. Childhood obesity: basics about childhood obesity. Available at: www.cdc.gov/obesity/childhood/basics.html. Accessed April 2, 2012
23. Robinson RF, Batisky DL, Hayes JR, Nahata MC, Mahan JD. Body mass index in primary and secondary pediatric hypertension. *Pediatr Nephrol*. 2004;19(12):1379–1384
24. Skinner AC, Mayer ML, Flower K, Perrin EM, Weinberger M. Using BMI to determine cardiovascular risk in childhood: how do the BMI cutoffs fare? *Pediatrics*. 2009;124 (5). Available at: www.pediatrics.org/cgi/content/full/124/5/e905
25. Genovesi S, Antolini L, Giussani M, et al. Hypertension, prehypertension, and transient elevated blood pressure in children: association with weight excess and waist circumference. *Am J Hypertens*. 2010;23(7): 756–761
26. Genovesi S, Antolini L, Giussani M, et al. Usefulness of waist circumference for the identification of childhood hypertension. *J Hypertens*. 2008;26(8):1563–1570
27. Rosner B, Prineas R, Daniels SR, Loggie J. Blood pressure differences between blacks and whites in relation to body size among US children and adolescents. *Am J Epidemiol*. 2000;151(10):1007–1019
28. Sinaiko AR. Hypertension in children. *N Engl J Med*. 1996;335(26):1968–1973
29. Benson L, Baer HJ, Kaelber DC. Trends in the diagnosis of overweight and obesity in children and adolescents: 1999–2007. *Pediatrics*. 2009;123(1). Available at: www.pediatrics.org/cgi/content/full/123/1/e153
30. Riley MR, Bass NM, Rosenthal P, Merriman RB. Underdiagnosis of pediatric obesity and underscreening for fatty liver disease and metabolic syndrome by pediatricians and pediatric subspecialists. *J Pediatr*. 2005;147(6):839–842
31. Chaudhry B, Wang J, Wu S, et al. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med*. 2006;144(10): 742–752
32. Samal L, Linder JA, Lipsitz SR, Hicks LS. Electronic health records, clinical decision support, and blood pressure control. *Am J Manag Care*. 2011;17(9):626–632
33. Romano MJ, Stafford RS. Electronic health records and clinical decision support systems: impact on national ambulatory care quality. *Arch Intern Med*. 2011;171(10):897–903
34. Linder JA, Ma J, Bates DW, Middleton B, Stafford RS. Electronic health record use and the quality of ambulatory care in the United States. *Arch Intern Med*. 2007;167 (13):1400–1405
35. Svenson JE, Repplinger M. Hypertension in the ED: still an unrecognized problem. *Am J Emerg Med*. 2008;26(8):913–917
36. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of hypertension in children and adolescents. *JAMA*. 2007;298(8):874–879
37. Ricke TL, Hendry PL, Kalynych C, Buzaianu EM, Kumar V, Redfield C. Incidence and recognition of elevated triage blood pressure in the pediatric emergency department. *Pediatr Emerg Care*. 2011;27(10):922–927

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