Childhood Hypertension: An Underappreciated Epidemic?

Kevin D. Hill, MD, MSCI, Jennifer S. Li, MD, MHS

It is no secret that the United States and much of the developed world are in the midst of a pediatric obesity epidemic. Perhaps less recognized is that childhood hypertension is now one of the most common health concerns in children. Recent data from NHANES demonstrate prehypertension or hypertension in 19.2% of adolescent-age boys and 12.6% of girls, an estimated 38% increase compared with NHANES III data collected from 1988 to 1994.¹ In their analysis in this issue of *Pediatrics*, Kaelber and colleagues² used data from the Comparative Effectiveness Research from the Collaborative Electronic Reporting Consortium, a network of over 2000 pediatric primary care clinicians coordinated by the American Academy of Pediatrics, to evaluate the diagnosis and treatment of pediatric hypertension. Their study population included just under 400 000 children (ages 3–18 years) evaluated in primary care settings between 1999 and 2014. They document a 3.3% prevalence of hypertension, consistent with multiple previous analyses where the prevalence has ranged from ~2% to 5%.^{1,3–6} Most notably, they report low rates of diagnosis and treatment. Of 12 138 children and adolescents with charted blood pressures (BPs) >95th percentile (at a minimum of 3 separate clinic visits), only 23% had associated *International Classification of Diseases, Ninth Revision, Clinical Modification* codes for a hypertension-related diagnosis and only 5.6% of those with diagnosed hypertension received antihypertensive drug treatment. There is now substantial evidence linking childhood hypertension

to long-term cardiovascular risk. Childhood hypertension is associated with increased carotid intima media thickness, increased left ventricular mass, and increased arterial stiffness,^{7–13} all precursors to adverse cardiovascular outcomes in adulthood. It is safe to assume that the current childhood metabolic syndrome (hypertension/obesity/insulin resistance) epidemic will eventually reverse several decades of improving cardiovascular outcomes in the United States. For these reasons, current guidelines recommend pharmacologic treatment of children with documented stage I hypertension (BP >95th percentile), if lifestyle therapy fails to sufficiently improve BP, and also for children with symptomatic hypertension, secondary hypertension, or hypertension associated with diabetes or target organ damage.¹⁴ According to Kaelber and colleagues,² we are falling well short of these recommendations.

There may be some who question these findings. Are electronic health record (EHR)-charted BPs as accurate as those obtained in a research setting? How reliable are *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnostic codes, and how well do clinicians document EHR medication use? These are legitimate study limitations, yet there are compelling reasons to believe the results. The study definition of hypertension is consistent with current diagnostic guidelines.¹⁴ The reported 3.3% prevalence of hypertension is consistent with previous studies^{1,3–6} and the authors excluded practices that

Duke Clinical Research Institute and Division of Pediatric Cardiology, Department of Pediatrics, Duke University School of Medicine, Durham, North Carolina

Opinions expressed in these commentaries are those of the authors and not necessarily those of the American Academy of Pediatrics or its Committees.

DOI: 10.1542/peds.2016-2857

Accepted for publication Sep 22, 2016

Address correspondence to Kevin D. Hill, MD, MSCI, Duke Clinical Research Institute and Division of Cardiology, Department of Pediatrics, Duke University School of Medicine, Duke University Medical Center, P.O. Box 17969, Durham, NC 27715. E-mail: kevin.hill@duke.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2016 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: This work was supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under awards 1TL1TR001116 and UL1TR001117. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

COMPANION PAPER: A companion to this article can be found online at www.pediatrics.org/cgi/doi/10.1542/peds.2016-2195.

To cite: Hill KD and Li JS. Childhood Hypertension: An Underappreciated Epidemic?. *Pediatrics*. 2016; 138(6):e20162857

did not consistently capture key EHR-based data points.

In short, these findings are compelling and highlight the shortcomings of our current practice. As pediatricians, we must carefully consider whether we are appropriately diagnosing and managing hypertension in our patients. Hypertension is indeed more challenging to diagnose in children because of age, sex, and height-related variability in BP norms. A BP of 112/76 may not seem high, but it meets the definition for stage I hypertension in, for example, a short 8-year-old boy.¹⁴ To avoid underdiagnosis, evaluation of BP percentiles should be a routine part of pediatric practice.

Appropriate treatment is another issue. A prevalence of 3.3% suggests that 2.2 million children and adolescents require evaluation and possible treatment of hypertension. These patient numbers exceed the capacity of subspecialist providers in the United States and, therefore, primary care pediatricians will have to become more comfortable prescribing antihypertensive drugs. This burden could be eased if the next iteration of pediatric hypertension guidelines were to provide expert consensus to guide treatment initiation. These recommendations could borrow from a wealth of new data on antihypertensive drug dosing, safety, and efficacy in children. Since publication of 2004 guidelines from the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents for diagnosis and treatment of high BP in children, 13 different antihypertensive drugs have been evaluated in clinical trials in children under the pediatric exclusivity provision. Nine of these drugs received a new labeled indication for treatment of pediatric hypertension.¹⁵ Moreover, new safety data have emerged, such as

the potential teratogenic effects of angiotensin converting enzyme inhibitors.¹⁶

Despite progress, there is a continuing need for additional study. Future antihypertensive drug trials need to consider stratified enrollment to evaluate safety, efficacy, and dosing based on race, sex, and/or presence of other important comorbidities, such as insulin resistance and obesity. There is a need for head-to-head comparisons of drugs in different classes and studies are needed to better evaluate effectiveness of lifestyle interventions, which are currently appropriately recommended as first-line therapy for children with stage I hypertension.¹⁴ Despite these unanswered questions, it is clear that childhood hypertension is a major public health concern. The clinical manifestations may be silent during childhood, but this should not deter early diagnosis and treatment.

ABBREVIATIONS

BP: blood pressure
EHR: electronic health record

REFERENCES

1. Rosner B, Cook NR, Daniels S, Falkner B. Childhood blood pressure trends and risk factors for high blood pressure: the NHANES experience 1988-2008. *Hypertension*. 2013;62(2):247-254
2. Kaelber DC, Weiwei L, Ross M, et al; Comparative Effectiveness Research Through Collaborative Electronic Reporting Consortium. Diagnosis and medication treatment of pediatric hypertension: a retrospective cohort study. *Pediatrics*. 2016;138(6):e20162195
3. Din-Dzietham R, Liu Y, Bielo MV, Shamsa F. High blood pressure trends in children and adolescents in national surveys, 1963 to 2002. *Circulation*. 2007;116(13):1488-1496
4. Flynn J. The changing face of pediatric hypertension in the era of the childhood obesity epidemic. *Pediatr Nephrol*. 2013;28(7):1059-1066
5. 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.e1
6. Sorof JM, Lai D, Turner J, Poffenbarger T, Portman RJ. Overweight, ethnicity, and the prevalence of hypertension in school-aged children. *Pediatrics*. 2004;113(3 pt 1):475-482
7. Juhola J, Magnussen CG, Berenson GS, et al. Combined effects of child and adult elevated blood pressure on subclinical atherosclerosis: the International Childhood Cardiovascular Cohort Consortium. *Circulation*. 2013;128(3):217-224
8. 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
9. 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
10. Raitakari OT, Juonala M, Kähönen M, et al. Cardiovascular risk factors in childhood and carotid artery intima-media thickness in adulthood: the Cardiovascular Risk in Young Finns Study. *JAMA*. 2003;290(17):2277-2283
11. Brady TM, Fivush B, Flynn JT, Parekh R. Ability of blood pressure to predict left ventricular hypertrophy in children with primary hypertension. *J Pediatr*. 2008;152(1):73-78.e1
12. McNiece KL, Gupta-Malhotra M, Samuels J, et al; National High Blood Pressure Education Program Working Group. Left ventricular hypertrophy in hypertensive adolescents: analysis of risk by 2004 National High Blood Pressure Education Program Working Group staging criteria. *Hypertension*. 2007;50(2):392-395
13. Stabouli S, Kotsis V, Rizos Z, et al. Left ventricular mass in normotensive,

prehypertensive and hypertensive children and adolescents. *Pediatr Nephrol*. 2009;24(8):1545–1551

14. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004;114(2 suppl, 4th report):555–576
15. Chu PY, Campbell MJ, Miller SG, Hill KD. Anti-hypertensive drugs in children and adolescents. *World J Cardiol*. 2014;6(5):234–244
16. Cooper WO, Hernandez-Diaz S, Arbogast PG, et al. Major congenital malformations after first-trimester exposure to ACE inhibitors. *N Engl J Med*. 2006;354(23):2443–2451