User-friendly tools to identify elevated blood pressure in children

Arnaud Chiolero MD PhD[1], Gilles Paradis MD MSc[2]

Despite weak evidence of benefits, paediatricians are increasingly urged to screen children and adolescents for cardiovascular risk factors, including elevated blood pressure (BP). The United States (US) National Heart, Lung and Blood Institute, and the European Society of Hypertension recommend that children three years of age and older have their BP measured either at every medical encounter or annually (1,2). Screening for elevated BP is, however, not performed regularly in children. For instance, in a recent study conducted in the US, screening for elevated BP occurred in 35% of ambulatory paediatric visits (3). Even when BP is measured, hypertension is frequently underdiagnosed in children (4).

On one hand, the low uptake of BP screening in children can be explained by physicians' low awareness of the screening recommendations and by the belief that elevated BP screening is not beneficial in children. If the latter is true, the low rate of screening is not of concern. There are indeed serious questions about the benefits and harms of elevated BP screening in children, notably because the absolute risk of cardiovascular diseases associated with a given level of BP in childhood and the long-term impact of antihypertensive treatment beginning in childhood are not known, and because no study has experimentally assessed the benefits and harms of BP screening in children (5). Consequently, the US Preventive Services Task Force does not endorse a specific recommendation for or against BP screening in children.

On the other hand, if one assumes that elevated BP screening is beneficial in children, then the rate of screening should be improved. Identification of elevated BP is, however, difficult in children (6). One major difficulty is the numerous BP thresholds used to define elevated BP, which are sex, age and height specific (2,7). Accounting for both sexes, 17 age categories and seven height percentile categories, there are 476 specific thresholds for the 95th percentile of systolic and diastolic BP of children from one to 17 years of age. These numerous thresholds are difficult to use in practice and a limiting factor to increasing uptake of BP screening in children. Simple, user-friendly tools would be of great help to clinicians for identifying elevated BP in children.

Several methods to ease the identification of elevated BP in children exist (Table 1) (8-11) and could improve the detection of elevated BP in children. For instance, Mitchell et al (11) produced a table with 10 BP thresholds, with increments of 5 mmHg, using three-year age categories, independent of sex or height. Implementation of this table in a university-based paediatric clinic led to a large increase in the identification of children with elevated BP.

TABLE 1
Tools to identify children with elevated blood pressure (BP)

Tool (references)	Issue
Simple equations relating BP thresholds to age (8,10)	It requires calculations at the point of care; their ability to identify children with elevated BP has to be determined.
Simple tables with few BP thresholds (9,11)	Multiple possible tables can be proposed and their ability to identify children with elevated BP has to be compared.
Blood pressure-to-height ratio (12-17)	It requires calculations at the point of care; the optimal cut-off points have to be established.

Because BP is related to height in children, an elevated BP to height ratio (BPHR) has recently been proposed as an indicator of elevated BP (12-16). In the current issue of the *Journal*, Guo et al (pages 65-69) assessed the performance of BPHR to identify children with elevated BP (17). In this study conducted in a rural area of China, 6837 children and adolescents five to 18 years of age had their BP measured twice on one occasion. Elevated BP was defined as either systolic BP or diastolic BP at or above the 95th sex-, age- and height-specific percentile (US reference). Both systolic BPHR and diastolic BPHR accurately identified elevated BP: the areas under ROC curves of systolic BPHR and diastolic BPHR were between 0.94 and 0.99 for elevated systolic BP and elevated diastolic BP. The optimal cut-off points for children five to 12 years of age were 0.84 mmHg/cm for systolic BPHR and 0.54 mmHg/cm for diastolic BPHR in boys and 0.83 mmHg/cm and 0.53 mmHg/cm in girls, respectively. For children 13 to 18 years of age, the optimal cut-off points were 0.77 mmHg/cm for systolic BPHR and 0.48 mmHg/cm for diastolic BPHR in boys and 0.79 mmHg/cm and 0.51 mmHg/cm in girls, respectively (17).

Studies conducted in other populations have also shown the ability of BPHR to identify subjects with elevated BP, in both sexes, in children as well as in adolescents (12-16). Nevertheless, it is too early to adopt BPHR for the screening of elevated BP. Optimal cut-off points have to be determined and tested in various populations. Their positive and negative predictive values for the detection of elevated BP have to be determined. Because BPHR could have a residual relationship with height, it is necessary to assess whether such predictive values are the same across height categories. Furthermore, it is unclear what the role of BPHR would be in the process from BP screening to the diagnosis of hypertension. It is also critical to assess whether the use of BPHR improves

[1]*Institute of Social and Preventive Medicine, Lausanne University Hospital, Lausanne, Switzerland;* [2]*Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Quebec*

Correspondence: Dr Arnaud Chiolero, Institute of Social and Preventive Medicine (IUMSP), Lausanne University Hospital, Biopôle 2, 10 route de la Corniche, Lausanne 1010, Switzerland. Telephone 41-21-314-72-72, fax 41-21-314-7- 73, e-mail arnaud.chiolero@chuv.ch

Accepted for publication November 22, 2012

screening uptake and detection of elevated BP in various clinical settings. In practice, even if a simple and valid set of cut-off points are identified, using BPHR will be difficult because it requires computing a ratio at the point of care. Meanwhile, clinicians can avoid unfriendly BP tables and determine BP percentiles in children by using applications for smartphones (18) or online calculators (19).

REFERENCES

1. National Heart, Lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: Summary report. Pediatrics 2011;128(Suppl 5):S213-56.
2. Lurbe E, Cifkova R, Cruickshank JK, et al. Management of high blood pressure in children and adolescents: Recommendations of the European Society of Hypertension. J Hypertens 2009;27:1719-42.
3. Shapiro DJ, Hersh AL, Cabana MD, Sutherland SM, Patel AI. Hypertension screening during ambulatory pediatric visits in the United States, 2000–2009. Pediatrics 2012;130:604-10.
4. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of hypertension in children and adolescents. JAMA 2007;298:874-9.
5. Chiolero A, Bovet P, Paradis G. Screening for elevated blood pressure in children. A critical appraisal. JAMA Pediatrics 2013. (In press)
6. Chiolero A, Paradis G, Lambert M. Accuracy of oscillometric devices in children and adults. Blood Press 2010;19:254-9.
7. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004;114(2 Suppl 4th Report):555-76.
8. Somu S, Sundaram B, Kamalanathan AN. Early detection of hypertension in general practice. Arch Dis Child 2003;88:302.
9. Kaelber DC, Pickett F. Simple table to identify children and adolescents needing further evaluation of blood pressure. Pediatrics 2009;123:e972-4.
10. Simonetti GD, Rizzi M, Bianchetti MG. Simple references for managing arterial hypertension in children with kidney disease. J Hypertens 2010;28:1109.
11. Mitchell CK, Theriot JA, Sayat JG, Muchant DG, Franco SM. A simplified table improves the recognition of paediatric hypertension. J Paediatr Child Health 2011;47:22-26.
12. Lu Q, Ma CM, Yin FZ, Liu BW, Lou DH, Liu XL. How to simplify the diagnostic criteria of hypertension in adolescents. J Hum Hypertens 2011;25:159-63.
13. Rabbia F, Rabbone I, Totaro S, et al. Evaluation of blood pressure/height ratio as an index to simplify diagnostic criteria of hypertension in Caucasian adolescents. J Hum Hypertens 2011;25:623-4.
14. Ejike CE. Blood pressure to height ratios as simple, sensitive and specific diagnostic tools for adolescent (pre)hypertension in Nigeria. Ital J Pediatr 2011;37:30.
15. Lu Q, Ma C, Yin F, Wang R, Lou D, Liu X. Blood pressure-to-height ratio as a screening measure for identifying children with hypertension. Eur J Pediatr 2012 Oct 5. [Epub ahead of print]
16. Galescu O, George M, Basetty S, et al. Blood pressure over height ratios: Simple and accurate method of detecting elevated blood pressure in children. Int J Pediatr 2012;2012:253497.
17. Guo X, Zheng L, Li Y, Zhang X, Yu S, Sun Y. Blood pressure-to-height ratio: A novel method for detecting hypertension in pediatric age groups. Paediatr Child Health 2013:18;65-69.
18. Pediacents. <www.pediacents.com/> (Accessed October 16, 2012).
19. Age-based Pediatric Blood Pressure Reference Charts. <www.bcm.edu/bodycomplab/Flashapps/BPVAgeChartpage.html> (Accessed October 16, 2012).