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Pediatric hypertension: a toolkit for optimizing lifestyle and pharmacologic adherence

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Abstract

Hypertension (HTN) has significant long-term cardiovascular risks and is becoming increasingly prevalent in the pediatric population. Apart from making the diagnosis of HTN and initiating treatment, sustained adherence to lifestyle modifications is the mainstay of pediatric HTN management. Little is described regarding compliance to lifestyle recommendations as treatment for HTN despite current guidelines outlining specific dietary and physical activity recommendations that are suggested to be equated to medical prescriptions. This is possibly because there are more objective metrics such as pharmacy pick-up/refill data that can more accurately track medication compliance. The purpose of this review is to provide the general pediatrician with a standardized framework for the management of pediatric HTN with a focus on objective tools that will enable a pragmatic approach to evaluating patient compliance. Adherence to lifestyle modifications focusing on diet and physical activity may potentially impact blood pressure control beyond drug therapy compliance. Concise flowsheets and tables are provided to aid the pediatrician's workflow in a busy clinic whilst providing essential objective data to assess patient compliance and provide nutrition and physical activity prescriptions. In this review, we outline our current understanding of lifestyle modification and medication prescription compliance trends among youths with HTN and offer real-world tools to implement in any pediatric clinic to better understand and improve patient compliance.

Keywords

Pediatrics, hypertension, compliance, lifestyle

Introduction

Cardiovascular disease remains a leading cause of death in the United States [1]. Hypertension (HTN) is a key driver in the atherosclerotic process and increases the risk of stroke, myocardial infarction, chronic

kidney disease, and heart failure. Guideline-based diagnostic criteria for HTN in youths vary by age [2], but recent NHANES data reported rates of HTN in patients aged 8–17 years to be 4.9% with 13% having abnormal blood pressure [3]. After the age of six years, essential HTN becomes the leading cause of abnormal blood pressure [4]. Along with inherited and anatomic etiologies of HTN, cardiometabolic risk factors such as obesity and insulin resistance have contributed to a three-fold increase in childhood HTN [5]. Children with obesity and children with HTN experience alterations in cardiac size and function as well as vascular changes that when found in adults, can be predictors of cardiovascular morbidity and mortality [6]. Furthermore, childhood blood pressure influences adult blood pressure measures. Data from the Bogalusa Heart Study demonstrated that elevated blood pressure persisted from childhood into adulthood [7]. A different cohort found that the number of abnormal blood pressure readings in childhood can be predictive of adult HTN [8]. While there are guidelines in the measurement of blood pressure assessment of vascular stiffness in pediatrics continues to evolve [9–11]. Lifestyle modifications such as dietary adjustments and increases in physical activity remain the cornerstones of treatment for youth with HTN, especially when secondary to overweight or obesity. When provided in a structured environment, engaging in regular physical activity and consuming a balanced diet with appropriate levels of sodium has been shown to reverse the early target organ changes seen in pediatric patients with HTN [12]. Pharmacotherapy is reserved for after a trial of lifestyle interventions and in those with symptomatic HTN, stage 2 HTN without a known cause, HTN associated with chronic kidney disease, or HTN in a patient with diabetes [2]. Antihypertensive agents are safe and effective therapies for pediatric HTN [13–15], but compliance with medications can be jeopardized by side effects, forgetfulness, expense, skepticism around need for treatment, and emotion regarding potential need for lifelong therapy [12]. Assessing compliance to lifestyle interventions poses several challenges. Food and beverage consumption logs rely on recall that lends itself to several biases. Another challenge in pediatric clinical practice remains the clinical constraints to the use of standardized diet and exercise prescriptions for HTN. Many times, a routine pediatric well child visit may not have the time or personnel to provide these prescriptions that structured preventive cardiology or multidisciplinary obesity medicine clinics with counsellors, nutritionists, and exercise physiologists may be able to deliver. The purpose of this review is to reflect on the literature regarding compliance rates among pediatric patients with HTN prescribed lifestyle therapies and medications, and to offer tools to pediatricians on how to improve the assessment of and compliance to guideline-recommended lifestyle therapies.

Medication compliance

The World Health Organization (WHO) defines adherence as the extent to which a person's behavior corresponds with agreed-upon recommendations from a health care provider [13]. In adults in the United States, the WHO estimates the adherence of patients with HTN to their treatment regimen to be 51%, with developed countries faring even worse [13]. In one sample of almost half a million adults, only 72% of patients with HTN were at least 80% compliant with their antihypertensive medication [14]. Poor adherence may result in uncontrolled HTN. There are numerous proposed mechanisms for poor treatment adherence. Patient-centered factors for poor blood pressure control include limited access to health care and inability to obtain prescriptions due to travel barriers [16]. Patient perceptions of medication efficacy and mistrust of medical professionals may also limit compliance [17]. Within pediatrics, medication non-compliance in children with chronic diseases has been associated with disease-related complications, increased number of emergency room visits, and hospitalizations [18]. In addition, medication adherence may reduce overall healthcare costs [18]. In a small sample of adolescents with essential HTN prescribed drug therapy, almost half had uncontrolled HTN [19]. However, those who were adherent to their medication prescription based upon pharmacy refill data exhibited better BP control. The authors also found that adherence determined by self-reporting did not correlate with blood pressure control and that there are potential racial disparities in medication adherence, and recommended leveraging the use of electronic medical records and pharmacy refill records as means of improving medication compliance.

Lifestyle modification compliance

Behavioral modifications targeting a heart-healthy diet and increasing physical activity are considered first-line treatments for pediatric HTN. While not traditionally considered during a visit for primary HTN, sleep hygiene plays a role in blood pressure regulation. Indeed, longer sleep duration in childhood has correlated with lower daytime blood pressures [20], keeping with the emphasis on adequate sleep in the American Heart Association's Life's Essential 8. Dietary changes emphasizing increased consumption of whole grains, vegetables, fruits, lean proteins, low-fat dairy, and fiber and limiting saturated fats, sugar-sweetened beverages, and sodium are recommended to improve cardiometabolic health. Unfortunately, American youths demonstrate poor adherence to national dietary guidelines. Banfield et al. [21] found that children and adolescents in the United States scored well below the accepted cutoff for good health on the Healthy Eating Index and suggested that diet in childhood is an important target to help reduce diet-related adult disease. Dietary sodium intake was positively correlated with systolic blood pressure in a large sample of United States children and adolescents [22]. Additionally, sodium consumption even during the neonatal period is associated with higher blood pressures in the adolescent years than those neonates who followed a low-sodium diet [23]. Youth who consumed higher amounts of fruits and vegetables were shown to have lower systolic blood pressure in a large cross-sectional analysis of adolescents [24]. The Dietary Approaches to Stop Hypertension (DASH) diet encompasses many of these recommendations and is the primary dietary strategy recommended by the American Academy of Pediatrics to combat pediatric HTN [2]. Components of the DASH pattern were associated with lower systolic and diastolic blood pressure in a subset of adolescent females followed over a 10-year period, even after adjusting for body mass index [25]. A longitudinal study involving children and adolescents showed that better adherence to the DASH style diet correlated with improved markers of cardiometabolic health, including blood pressure [26]. However, achieving these results often requires frequent contact points with patients via nutrition experts and sustained follow-up that may not be feasible for families and clinics to maintain [27].

Physical activity is an effective means of reducing BP in pediatric patients [28–30]. The optimal exercise prescription for children is still unknown; however, the American Academy of Pediatrics recommends 30–60 minutes of moderate to vigorous physical activity at least 3 to 5 days per week to help lower blood pressure. Unfortunately, survey data indicates that only 27% of adolescents met recommended amounts of physical activity [31]. More concerning is that objective data indicates even fewer (8–9%) meet the recommended guidelines [32], highlighting the discrepancy between self-reported levels of activity and objective measures that makes accurate assessments difficult in the clinical setting. From a patient perspective, one of the bigger problems today with diet and exercise recommendations is either "information overload" with contradictory guidance through the internet and social media versus a "one-size-fits-all" approach with vague non-specific information.

What follows is a real-world example of our clinical throughput at the Center for Cardiovascular Disease Prevention, Investigation, and Diagnostics (CVPID) clinic at Le Bonheur Children's Hospital in Memphis, Tennessee. Our clinic utilizes a compilation of resources collected from multiple sources that we have found translates guideline-directed recommendations for screening and management of pediatric HTN into patient- and family-friendly educational materials. This is a single-center experience and may not be generalizable to all sites. Our goal is to provide pediatric clinics with a blueprint from which to implement strategies that may improve overall patient compliance, clinic satisfaction, and, most importantly, patient outcomes.

Assessment of blood pressure

Consistency in measurement of blood pressure in a clinical practice is extremely important in engaging the family in lifestyle interventions. This is especially important in pediatric HTN where white-coat HTN is a factor. Assessment of blood pressure should be performed at each visit starting at age 3 years. Blood pressure should be measured in a quiet room. The patient should be seated in a comfortable chair with back supported and feet placed flat on the ground. The legs should not be crossed. Blood pressure is preferably taken in the right arm. The arm should be raised to the level of the heart and should be

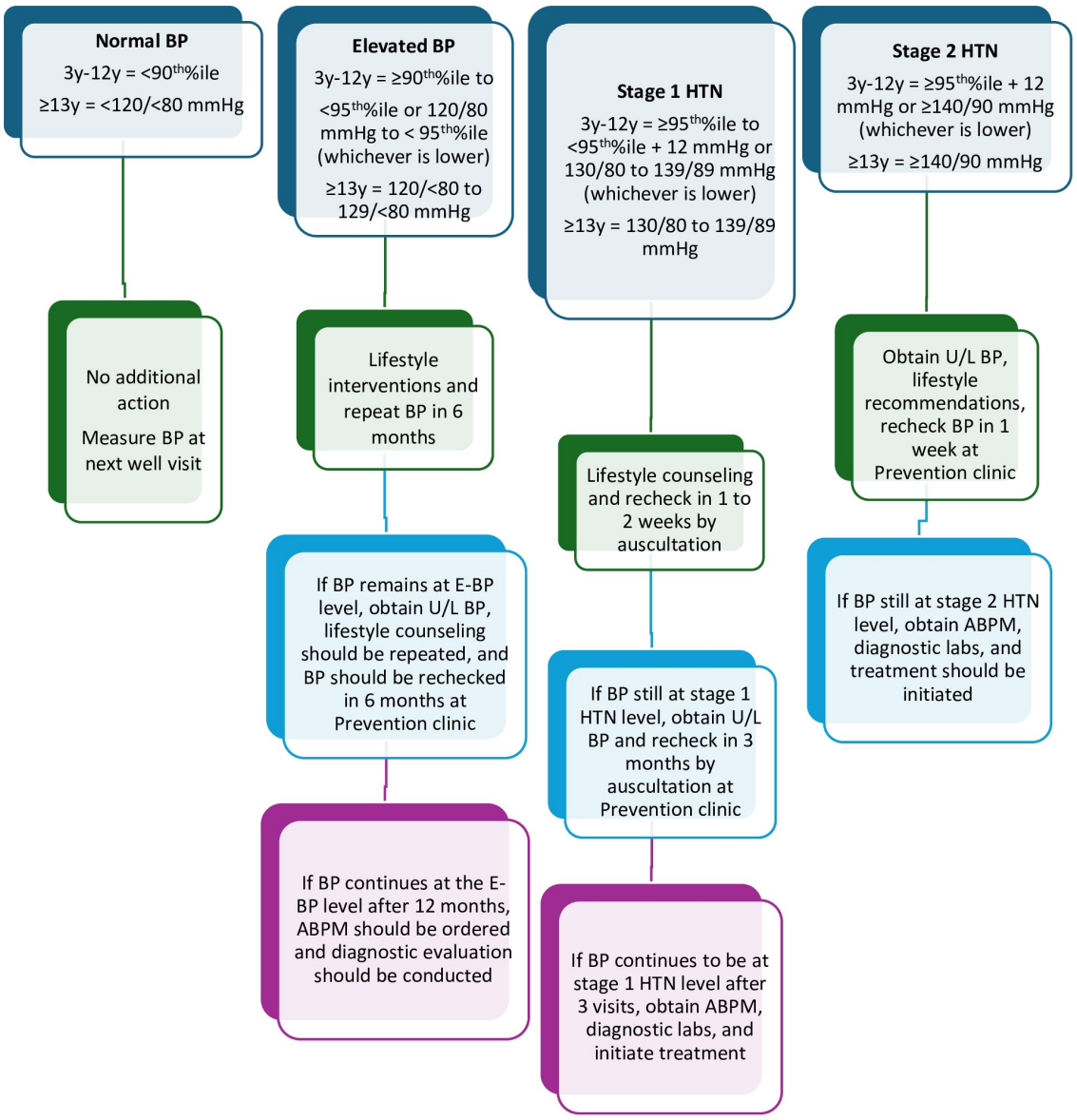

Figure 1. Hypertension clinical pathway. BP: blood pressure

supported by the examiner or a table/counter. See a demonstration of proper blood pressure measurement technique at the following link (https://www.iphapediatrichypertension.org//). Employing an appropriately sized blood pressure cuff is essential for obtaining an accurate measurement. Cuff size should be chosen based on the size of the child's arm. The inflatable bladder of the cuff should encircle 40% of the patient's upper arm with the length of the bladder encompassing at least 80% of the arm's circumference. Inappropriate cuff size can lead to over- or under-estimation of the true blood pressure. Initial blood pressures can be taken by an oscillometer to facilitate clinic workflow, but if abnormal, two additional blood pressures by auscultation should be performed and averaged to define the blood pressure [2]. The definitions of the different blood pressure categories per the 2017 Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents [2] are shown as part of Figure 1. For children < 13 years of age, utilization of a blood pressure calculator can facilitate easy interpretation of recommended blood pressure cutoffs (https://www.mdcalc.com/calc/4052/aap-pediatric-hypertension-guidelines). The preventive cardiology clinical pathway after assessment of BP is shown in Figure 1.

Education on the significance of an abnormally high blood pressure

Clear and consistent messaging on the long-term effects of high blood pressure must be stressed to the family. This provides the family with a reason to "buy-in" to the lifestyle interventions that are suggested. Oftentimes, HTN is present in several family members. This provides an opportunity to underscore the likely genetic predisposition to HTN and can provide empathetic reassurance that the disease is not necessarily the patient's "fault". Unfortunately, some family members may have known target organ damage (increased aortic stiffness, left ventricular hypertrophy, neurocognitive deficiencies, reno-vascular disease) [5] or have suffered clinical events (stroke, myocardial infarction) related to their HTN. In this scenario, it is important to provide empathetic care but to also highlight the potential benefits of early recognition and treatment in order to reduce the risk of future cardiovascular events in the patient [5]. Indeed, it is not only the absolute value of the blood pressure, but the blood pressure burden on the cardiovascular system over the life course that matters for cardiovascular outcomes [29].

Dietary recommendations

While the DASH diet is the recommended dietary modification put forth by the American Academy of Pediatrics, the information provided can be overwhelming for the family. There are gaps in knowledge on the understanding of what is healthy and what entails saturated and unsaturated fats, for instance. Less information may be "more" in some situations. In addition, many clinics may not have access to a registered dietitian who is available to work with families to provide a tailored dietary intervention. A succinct simple hand-out which emphasizes fruits, vegetables, whole grains, lean proteins, and low-fat dairy while limiting salt, sugar, and saturated fats as suggested by the DASH diet with examples may be more effective. Our clinic likes to employ handouts provided by the National Lipid Association that provide examples of heart healthy food items as well as amounts that are recommended in a simple, easy-to-read format (https://www.lipid.org/clmt). These 1-page illustrations with examples referenced to specific demographics and regions (for example: heart healthy eating "southern style" or "on a budget") make them more practical for patient families, which may lend to better compliance.

Exercise prescription

The 2017 Clinical Practice Guidelines recommend children and adolescents to partake in 30–60 minutes of moderate to vigorous physical activity at least 3 days per week [2]. Unfortunately, many patients are unable to meet this recommendation [33]. Social determinants of health and knowledge of what constitutes physical activity may limit the acceptance of recommendations provided by the clinician [34]. Some patients who have been sedentary may be apprehensive to begin exercising due to some discomfort that may accompany physical activity. Education on expected heart rate changes, such as expected peak heart rate (220 bpm—age in years), may help alleviate some of that anxiety. It is also important to educate the family that it may take longer for the heart rate to come down to baseline levels at the start of an exercise program, i.e, deconditioned individuals may take a longer time for heart rate recovery compared to trained athletes. Providing an exercise "prescription" may also enhance compliance. Our clinic employs the exercise prescription form available through the Exercise is Medicine program from the American College of Sports Medicine. While this form is geared towards adults, we find the descriptions of the different intensities of activities and the acknowledgement of strength training helpful. The form can be filled out to comply with current recommendations for younger patients. We also measure patient-reported physical activity through an abridged version of the Patient-Reported Outcomes Measurement Information System (PROMIS) for Pediatric Physical Activity, a validated method for measuring self-reported outcomes [35]. These surveys are sent electronically to families via the electronic medical record to be completed prior to their appointment time. If the surveys have not been filled out prior to their arrival, the surveys are then completed in-person and reviewed with the family during their visit. We find this saves time during the visit, which can then be used to employ motivational interviewing techniques that have been shown to be effective in effecting behavior change [5].

Preventive Cardiology Clinic Lifestyle Survey

The Preventive Cardiology clinic would like to gather information regarding lifestyle habits that will facilitate your clinic visit today. Please answer each question to the best of your ability.

PHYSICAL ACTIVITY ASSESSMENT

How many days per week do you engage in any form of physical activity?

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ 7

How many days per week do you engage in vigorous-intensity activity? (meaning effort exerted is rated >7 out of 10 on a 10-point scale)

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ 7

On days you are active, about how many minutes are you active for?

☐ 0-10 minutes ☐ 10-20 minutes ☐ 20-30 minutes ☐ 30-60 minutes ☐ ≥60 minutes

If you engage in physical activity less than 3 days per week, what would help increase the number of days you are active?

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NUTRITIONAL ASSESSMENT

Whole Grains

How many ounces of whole grains do you consume on a daily basis? (Examples of 1 ounce of whole grains: 1 slice of bread, 1 small tortilla, ½ cup of cooked brown rice, ½ cup of grits)

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ >7

Fruits

How many cups of fruit do you consume on a daily basis? (Examples of 1 cup of fruit: 1 small apple, 1 large banana, 1 cup of grapes, 1 cup 100% fruit juice)

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ >7

Vegetables

How many cups of vegetables do you consume on a daily basis? (Examples of 1 cup of vegetables: 2 cups raw spinach, 1 cup cooked collard/kale/turnip greens, 1 small avocado, 1 large sweet potato, 1 cup cooked beans/peas)

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ >7

Dairy

How many cups of dairy do you consume on a daily basis? (Examples of 1 cup of dairy:1 cup of dairy milk, 1 cup of yogurt, 1 cup soy milk, 1 ½ ounces of hard cheese)

☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ >7

MEDICATION ASSESSMENT

If you are prescribed a medication (or medications) to help lower your blood pressure, how many days per week do you miss a dose of your blood pressure medication(s)?

☐ N/A ☐ 0 ☐ 1 ☐ 1-2 ☐ 2 ☐ 2-3 ☐ 3 ☐ 3-4 ☐ 4 ☐ 4-5 ☐ 6 ☐ 6-7 ☐ 7

Lifestyle Survey

Figure 2. Preventive cardiology clinic lifestyle survey

Preventive cardiology clinic lifestyle survey

The preventive cardiology clinic lifestyle survey is a concise tool created to provide an objective measure of medication, diet, and exercise compliance while providing the patient and family with clarity on goals for the next visit. Surveys are provided to the patient at each visit upon triage by the clinic nurse. Patients (or their guardian as appropriate) fill out the survey while waiting for the clinician, and the results are reviewed during the clinical visit. Goals can be set based upon results, and then the survey is repeated at subsequent visits to assess progression towards recommended dietary and physical activity guidelines. While including components of the PROMIS score and basic nutritional metrics, it encourages the individual to compete with themselves by trying to "progress to the right" of the page with each metric at follow-up visits (Figure 2). It sets in motivation and discipline for the family while providing the clinician a starting point for each patient. This enables the creation of realistic targets for both the clinician and the family and nurtures a sense of teamwork.

Conclusion

Adherence to lifestyle modifications is a critical component in the management of pediatric HTN. Strategies to enhance compliance must be age-appropriate, family centered, pragmatic, and tailored to the child and the family. A standardized approach with lifestyle survey tools as shared in this review may potentially help compliance and provide both clinician and family accountability. Our approach to managing pediatric HTN may not be generalizable to outside institutions. Our hospital serves a metropolitan area with a majority African American population located in the Mid-South of the United States Certain cultural and environmental factors may impact physical activity or dietary recommendations. Availability of professional dietary counseling via Registered Dieticians may also impact effectiveness of interventions. Above is a working protocol that is designed for use by clinicians to aid in providing evidence-based lifestyle counseling within a resource-limited setting.

Abbreviations

HTN: hypertension

PROMIS: Patient-Reported Outcomes Measurement Information System

WHO: World Health Organization

Declarations

Author contributions

AW: Writing—original draft, Formal analysis. TY: Writing—review & editing. EH: Writing—review & editing. AH: Writing—review & editing. NP: Writing—review & editing. DS: Writing—review & editing. CC: Writing—review & editing. RP: Conceptualization, Methodology, Supervision, Writing—review & editing.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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Not applicable.

Consent to participate

Not applicable.

Consent to publication

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Availability of data and materials

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