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Comparison of Pediatrician Providers Versus Non-pediatrician Providers in Screening and Treatment of Adolescents (Ages 12-17) with Essential Hypertension

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Medical University of Ohio, 2005

Dedications

Without God, nothing is possible. My dear wife Chantel, you are my love and my guidance. And to all my family and friends, thank you for all the support you have given me over the years.

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Table of Contents

Table of Figures

Introduction

Essential hypertension in adolescents (ages 12-17) has received greater attention in recent years than in the past. According to the fourth report from the National High Blood Pressure Education Program (NHBPEP) essential hypertension is now a common occurrence among adolescents in the United States (U.S.) (NHBPEP, 2004). While hypertension in the very young is almost always due to an underlying secondary cause, most cases of high blood pressure encountered in adolescents (ages 12-17) have no known cause (Flynn, 2001). There have been several longitudinal studies over the last several decades illustrating the tendency for children and adolescents with even moderately elevated blood pressure to develop high blood pressure as adults (Bao, 1995; Lauer, 1989; Wilson, 1997).

Obesity rates among adolescents in the U.S. continue to grow profoundly. According to a survey conducted over 1999-2000 by the Third National Nutrition Examination Survey (NHANES III), 15.5% of 6 to 19 year-olds are overweight, with body mass indices (BMI) greater than the 95th percentile for their age (Ogden, 2002). Obesity not only enhances the risk of developing essential hypertension, especially in those that are genetically predisposed, but these individuals are also more likely to have problems with dyslipidemia and type 2 diabetes mellitus. The long-term consequences of poorly-controlled essential hypertension have been shown to significantly increase premature morbidity and mortality. Now more than ever, healthcare providers must be aware of these consequences. It is imperative that providers routinely screen adolescents for hypertension at every clinical visit in order to minimize the risk of developing the serious medical complications associated with long-standing hypertension

Problem Statement:

Elevated arterial blood pressure among adolescents in the U.S. has become an area of significant concern due to increasing prevalence. Long-standing poorly-controlled essential hypertension has been directly linked to very serious conditions including, heart disease, stroke, and kidney disease.

Research Hypothesis:

Pediatrician providers are more proficient than non-pediatrician providers in detecting and appropriately treating adolescents (ages 12-17) with essential hypertension.

Purpose:

The purpose of this study was to gain an understanding of current knowledge levels between pediatrician providers and non-pediatrician providers in detecting and appropriately treating adolescents (ages 12-17) with essential hypertension. The relevance of this study is associated with the increasing prevalence of obesity, and often subsequent increase in arterial blood pressure, among adolescents in the U.S. Based on research illustrating the harmful effects of long-standing essential hypertension, it would be simply unacceptable to fail in identifying and adequately treating patients in this population. As essential hypertension becomes a more common problem in adolescents, healthcare providers must be highly proficient in recognizing abnormal BP measurements, and knowledgeable with BP reduction methods.

Literature Review

Pathogenesis of Hypertension

Systemic arterial pressure is influenced by two physiologic variables: cardiac output and total peripheral resistance. Hypertension is usually due to increased peripheral resistance (Schoen, 2003). However, blood pressure (BP) can also be altered through an increase in cardiac output. Hypertension induced by increased cardiac output is commonly due to sodium imbalances. In humans, the etiology of hypertension is unknown (essential) in about 90-95% of cases of elevated BP (Fisher, 2005).

Essential Hypertension:

There are several factors involved in the development of essential hypertension. Genetics play a huge role in essential hypertension. It is thought that a number of different gene defects combine to express elevated BP. Environmental factors such as age, gender, race, weight, cholesterol levels, glucose intolerance, and in some cases, salt intake, are thought to play a role in the pathogenesis of hypertension, each to varying degrees (Schoen, 2003)

Essential hypertension is very complex in nature. So far, scientists have been unable to fully understand its pathogenesis. At this point, essential hypertension is treatable but incurable. Studies have shown that as patients age, especially those that are untreated, further increases in arterial pressure can be expected (Fisher, 2005).

Secondary Hypertension:

Secondary hypertension deals with specific causes of elevated arterial pressure that are identifiable and curable. An estimated 5-10% of individuals with high BP fall

into this category. The vast majority of cases involve the kidneys. This can be further broken down into renovascular and renal parenchymal hypertension. In renovascular hypertension, stenosis of renal artery perfusion is interrupted, and the renin-angiotensin system is activated. Angiotensin II elevates blood pressure through vasoconstriction. Angiotensin II also stimulates the release of aldosterone, which contributes to elevated BP primarily by promoting sodium retention (Ganong, 2005). It is believed that renal parenchymal disease ultimately results in hypertension through activation of the renin-angiotensin system as well. In this condition, however, decreased renal perfusion results from inflammatory and fibrotic changes in small intrarenal vessels (Ganong, 2005).

Endocrine abnormalities are another cause behind secondary hypertension in some cases. The adrenal cortex is responsible for a number of abnormalities that result in elevated BP. In primary aldosteronism, plasma sodium is retained and volume is expanded. Since potassium is shed in order to retain plasma sodium, patients will have low levels of potassium (Ganong, 2005). Cushing's syndrome and pheochromocytoma are two other examples of endocrine disorders that lead to secondary hypertension.

Other examples of causes of secondary hypertension include coarctation of the aorta, hypercalcemia, polycythemia vera, polyarteritis nodosa, and medications, such as steroids (Fisher, 2005). As previously mentioned, the hypertension associated with many of these conditions can be cured, unlike in essential hypertension. However, as scientists are able to further explore secondary causes of hypertension, there is a greater possibility that achievements can be made in understanding the pathogenesis of essential hypertension.

The majority of hypertension, while still harmful, is not usually associated with death within a few short years of its onset. Malignant hypertension accounts for only a small (estimated 5%) percentage of individuals with elevated arterial pressure. The etiology may consist of either secondary or idiopathic (essential) causes. In malignant hypertension, the elevated blood pressure goes undetected while even greater increases are seen within a short time period. Diastolic pressures are typically greater than 120 mmHg (Schoen, 2003). On the other end of the spectrum is benign hypertension, which accounts for the vast majority of cases.

Prevalence of Hypertension in the Adolescent Population

Poorly controlled essential hypertension continues to be a major contributor to premature morbidity and mortality in the U.S. It is strongly associated with many of the common disease processes seen in developed nations, such as cardiac, cerebrovascular, and renal disease. Despite being relatively easy to detect and adequately treat, there is still a significant number of people living with poorly controlled hypertension. In fact, as illustrated in the Framingham Study, roughly one-fifth of individuals had blood pressures greater than 140/90 mmHg in a white, suburban population sampled (Lloyd-Jones, 1999).

Elevated arterial blood pressure is not a problem exclusive to the adult population. While hypertension in infants and young children is almost always due to an underlying secondary cause, the majority of high blood pressure seen in the adolescent population is of an unknown etiology (Flynn, 2001). There have been several longitudinal studies over the last several decades illustrating the tendency for children and adolescents with even moderately elevated blood pressure to develop high blood

pressure as adults. This trend is compounded further in obese individuals and those with family histories of essential hypertension. The Bogalusa Heart study, conducted in Bogalusa, LA, examined BP progression in 1,501 subjects, between 2 and 24 years old, over several decades. Their results concluded that BP definitely tracks from childhood into adulthood. Their most prominent correlation with elevated BP persisting into adulthood involved subjects between the ages of 10 to 14 years. Normotensive subjects remained normotensive, while 68% with systolic BP greater than the 75th percentile for age remained in the upper quartile into the 9th year of follow-up (Bao, 1995).

The Muscatine study, conducted in Muscatine, Iowa, examined 2,445 children between the ages of 7-18 years. Blood pressure, height, and weight were recorded over the years 1971 to 1978. A sub-group was then recalled for repeat assessment between the ages of 23-28 years. The study concluded that those with systolic BP greater than the 90th percentile in childhood were four times more likely to have hypertension persisting into adulthood than those with normal systolic blood pressures. Findings for subjects with diastolic pressures greater than the 90th percentile were not as significant as with systolic pressures, but these individuals were still twice as likely to develop hypertension as adults (Lauer, 1989). The Framingham study also showed similar findings, indicating that elevated blood pressure in childhood and adolescence were more likely to continue into adulthood (Wilson, 1997).

Effects of Hypertension and Contributing Factors

The risk of premature death has been shown to be much greater in individuals with hypertension than in normotensive individuals. Chronic hypertension can have

serious effects on cardiac function itself. As cardiac muscle works against an increased pressure for an extended time period, this compensatory mechanism results in hypertrophy of the left ventricle. Eventually the function of the left ventricle becomes severely compromised because of the increased mass. The majority of deaths related to long-standing hypertension are congestive heart failure (CHF), and acute myocardial infarction (AMI) (Fisher, 2005).

There have been a number of studies involving the association of long-standing essential hypertension and increased left ventricular mass in adolescents. A study by Cook et al. showed a greater left ventricular mass in 10-16 year-olds that had a family history of essential hypertension, when measured against comparable subjects without histories of familial hypertension (Cook, 2000). Another study by Daniels et al. looked at children and adolescents with essential hypertension to determine the prevalence of left ventricular hypertrophy. Increases greater than the 99^{th} percentile for left ventricular mass in normal individuals were designated the cut point for this study (Daniels, 1998). De Simone et al. had previously found that a left ventricular mass index greater than 51 g/m^2.7 is associated with a fourfold increased risk of developing cardiovascular disease as an adult (de Simone, 1995). The study showed that 14% of the subjects had severe left ventricular hypertrophy, and another 17% had abnormal left ventricular geometry. Increased body mass was shown to have a strong positive correlation with essential hypertension and development of left ventricular hypertrophy, further illustrating the need for weight loss in overweight children and adolescents (Daniels, 1998).

A separate study by Daniels et al. examined left atrial hypertrophy in children and adolescents with essential hypertension. Essential hypertension was associated with left atrial hypertrophy in 51% of the 112 patients sampled (Daniels, 2002). Unlike many similar studies in the past that measure left ventricular mass, this study looked at atrial hypertrophy, which could eventually lead to problems such as atrial fibrillation, stroke, and congestive heart failure (Daniels, 2002).

Atrial fibrillation is a very common arrhythmia in the United States. This irregular rhythm is frequently associated with long-standing hypertension. A study by Healey points out that hypertension has far surpassed rheumatic heart disease as the most common cause of sustained atrial fibrillation in North America (Healey, 2003). Several factors are associated with the eventual development of atrial fibrillation. Left ventricular hypertrophy, and left atrial enlargement account for the structural changes described in this study. Changes in atrial electrophysiology occur early in the hypertension process, prior to appreciable structural changes. Slowing of the atrial conduction velocity occurs. Premature atrial contractions then become frequent as hypertension is left untreated, often precipitating atrial fibrillation. Individuals with atrial fibrillation have a 3- to 6-fold increased risk of stroke compared to those without this arrhythmia (Healey, 2003). The mechanism involves clot formation in the fibrillating atria. These clots can then travel to many locations in the body and become lodged, thus disrupting blood flow. The brain is frequently a target of these clots. This statistic is worsened further when untreated hypertension is factored into the equation. Patients must receive oral anticoagulation to prevent thromboembolic events from occurring. The study also claims that treatment of hypertension through pharmacologic means has

shown promise for eliminating atrial fibrillation, by reversing left atrial enlargement, and LVH (Healey, 2003).

Now more than ever, adolescents between the ages of 12-17 in the U.S. are at high risk for developing essential hypertension at an early age. Obesity in the U.S. has reached epidemic proportions among adolescents. According to a survey conducted over 1999-2000 by the Third National Nutrition Examination Survey (NHANES III), 15.5% of 6 to 19 year-olds are overweight, with body mass indices (BMI) greater than the 95th percentile for their age. Obesity is even more widespread among minority populations, with an estimated 23.6% of African Americans overweight among individuals between the ages of 6 and 19 years (Ogden, 2002).

The Bogalusa Study, conducted in Louisiana, examined trends in obesity in children and young adults, between the ages of 5 and 24 years, over an extended period of time. Defining overweight as the 85th percentile of weight for height, there was a twofold increase in prevalence in overweight individuals from 1973 to 1994. The study also showed that overweight children had a 1.5 to twofold increased likelihood of being heavy as adults (Freedman, 1997). The prevalence of overweight individuals was increased in both genders, and among African Americans and Caucasians. Unlike in many other studies, African Americans were not found to be at higher risk of becoming overweight when compared with Caucasians (Freedman, 1997).

Obesity alone has been shown to be a detriment to maintaining a healthy lifestyle. Several articles have considered the implications of being overweight as an adolescent. A study by He et al. determined truncal obesity to be a predictor of elevated systolic and diastolic blood pressure in boys in all stages of puberty. The

study looked at individuals of African American, Asian, and Caucasian descent. The results did not indicate any significant differences among races. Unlike males, females did not show a positive correlation between high central fat deposition and elevated blood pressure (He, 2002).

Overweight adolescents are also more likely to have problems with dyslipidemia, type 2 diabetes mellitus, and of course, hypertension. These are all major independent risk factors in the development of cardiovascular disease. The metabolic syndrome, also known as syndrome X, describes this cluster of health problems that can ultimately lead to many adverse health consequences. The metabolic syndrome has been defined by the Third Report of the Adult Treatment Panel (ATP III) as three or more of the following: hypertriglyceridemia, low high-density Lipoprotein (HDL), elevated fasting glucose, excessive waist circumference, and hypertension (ATP III, 2002). The metabolic syndrome serves as an assessment tool for clinicians when evaluating adults in the development of cardiovascular disease and diabetes mellitus. As of yet, no nationally accepted definition of the metabolic syndrome has been designated for children and adolescents. Ferranti et al examined adolescents, ages 12-19 years old, in order to determine the prevalence of the metabolic syndrome in this population. They used the ATP III guidelines with adjustments based on age. To fit their definition, 3 or more of the following were required: “Fasting triglycerides >100 mg/dL, HDL <50 mg/dL, except in boys aged 15 to 19 years, in whom the cutpoint was 45 mg/dL, fasting glucose >110 mg/dL, waist circumference >75th percentile for age and gender, and systolic blood pressure >90th percentile for gender, age, and height” (Ferranti, 2004). Their results indicated that an estimated 1 in 10 adolescents fits the definition of the metabolic

syndrome (Ferranti, 2004). Another article by Cook reviewed several studies involving the metabolic syndrome in the pediatric population. One example was by Goodman et al., who used adult standards in their assessment of the metabolic syndrome in teens (Goodman, 2004). As expected, very conservative numbers were obtained, with only 4.2% of teens meeting the ATP III guidelines (Cook, 2004). Cook emphasized the need for a definition of the metabolic syndrome in children and adolescents in order to better assess its prevalence in the pediatric and adolescent population.

It has been proposed in scientific literature that conditions favoring thrombotic events (prothrombotic states), as seen in myocardial infarction and stroke, are present in patients with hypertension and atherosclerosis. Felmeden et al. hypothesized that an increased state of thrombogenesis could be related to endothelial damage/dysfunction and abnormal angiogenesis (Felmeden, 2003). The study evaluated endothelial damage and prothrombotic states by measuring tissue factor (TF), von Willebrand Factor (vWF), flow-mediated dilatation (FMD), and vascular endothelial growth factor (VEGF). It was hypothesized that 6 months of anti-hypertensive therapy, and in some cases hypercholesterolemia treatment, would favorably alter the above factors, thus decreasing the risk for serious cardiovascular events. Their results confirmed the concept that abnormal thrombogenesis and angiogenesis, and endothelial damage/dysfunction are present in individuals with hypertension. It was also shown that significant improvements were made in participants' cardiovascular risk factor profiles following 6 months of pharmacologic treatment (Felmeden, 2003). Another study by Endemann et al. reinforces the idea of endothelial damage/dysfunction in individuals with hypertension, and its role in cardiovascular disease states. Along with

prothrombotic conditions, proinflammatory states, and reduced vasodilatory capacity also comprise the concept of endothelial dysfunction (Endemann, 2004).

Vascular health can suffer as a result of long-standing hypertension. In the Atherosclerosis Risk in Young Adults (ARYA) study, Vos et al. reviewed old health records of men and women between the ages of 27 and 30 years in order to obtain their blood pressure measurements during their early adolescent years. Researchers then proceeded to assess the carotid arteries of participants for evidence of atherosclerosis by carotid intima-media thickness (CIMT). They concluded that those individuals with the highest systolic blood pressures at a young age also had the greatest amount of thickening of the carotid arteries, thus increasing the risk of adverse cardiovascular events (Vos, 2003).

Even neurologic effects have been linked with elevated BP. Central nervous system dysfunction is a problem in individuals with long-standing hypertension. Serious conditions such as cerebral hemorrhage and cerebral infarction can result from hypertension. In a cerebral hemorrhage, elevated BP over an extended period of time can weaken arterial walls, and vascular aneurysms can result (Fisher, 2005). In cerebral infarction, the pathophysiology is similar to that of an AMI, in which atherosclerotic lesions play a key role. Less severe disorders such as headaches, especially occurring in the morning, decreased visual acuity, and light-headedness are other common early physical manifestations of chronic hypertension. Ophthalmoscopic examination allows direct visualization of retinal vasculature, which can illustrate progressive changes secondary to essential hypertension (Fisher, 2005).

A study by Lande et al. reviewed cognitive tests completed by 5,077 children. Of the participants, 3.4% had elevated systolic BP, while 1.6% had elevated diastolic BP. Their findings concluded that children with either systolic or diastolic hypertension >90th % had lower average scores on their tests (Lande, 2003). Persistence in the detection and treatment of essential hypertension in the adolescent population will likely pay large dividends in the prevention of many disease states that are currently developing at a premature age.

Monitoring Techniques

Hypertension in children and adolescents has been defined by the fourth report from the National High Blood Pressure Education Program (NHBPEP) as, “Systolic BP and/or diastolic BP greater than or equal to the 95th percentile for gender, age, and height on at least 3 separate occasions.” (NHBPEP, 2004) The new BP tables contain the 50th, 90th, 95th, and 99th percentiles for analysis of BP in children and adolescents. BP between the 90th and 95th percentile in childhood has been designated “high normal”, or prehypertension (NHBPEP, 2004). This differs from the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII) definition of prehypertension for all adults 18 years or older, which includes a systolic BP of 120-139 mmHg, and or a diastolic BP of 80-89 mmHg (JNC VII, 2003).

The Fourth Report insists that essential hypertension is a common occurrence in the adolescent population that is also readily detectable. The report provides guidelines for clinicians that include monitoring children greater than 3 years old for elevated BP during every health care incident, acquiring BP measurements through auscultation with

an appropriately sized cuff, and confirming above normal readings with repeat measurements. The systolic blood pressure is noted by the onset of Korotkoff sounds. Diastolic BP is marked by the cessation of Korotkoff sounds (the fifth Korotkoff sound). Oscillometric devices can be used for clinical BP monitoring, but elevated levels should be reevaluated by auscultation (NHBPEP, 2004).

Blood pressure is consistently changing throughout the day in response to various stimuli. Temporary fluctuations in BP can produce drastically elevated measurements, as seen in "white-coat hypertension." In this condition patients have BP greater than the 95th percentile when measured in a clinical setting, although they are otherwise normotensive. These individuals often require evaluation through ambulatory blood pressure monitoring (ABPM). This consists of utilizing devices that periodically measure BP over an extended period of time (usually 24 hours), thus gaining a better understanding of the patient's average daily arterial pressure (NHBPEP, 2004).

An article by Sinaiko, done in 2001, points out that ABPM appears to be an attractive option in the assessment of children and adolescents with mild hypertension. However, at that particular time, not enough clinical evidence had been accomplished demonstrating the effectiveness of this technique (Sinaiko, 2001). A more recent study by Lurbe et al. claims that research over the last several years has significantly improved previous shortages of normative data in ABPM. Improvements have also been seen with analysis of data, thus giving health care providers a better indication of when and how to treat adolescents with hypertension (Lurbe, 2004). This study points out another important concept. As already mentioned, hypertension is classified in the adolescent population as BP greater than the 95th percentile values based on height,

age, and gender. As the prevalence of obesity continues to increase in this country, blood pressure among adolescents will climb, ultimately allowing for higher blood pressures to be considered normal (Lurbe, 2004).

Not all experts are convinced that essential hypertension is a significant problem in the adolescent population. Unlike their recommendation for adults, the U.S. Preventive Services Task Force (USPSTF) has determined that there is inadequate evidence supporting the practice of screening adolescents for hypertension as a preventative measure in the development of cardiovascular disease. The Task Force does recognize that many other professional organizations, including the American Academy of Pediatrics (AAP), American Heart Association (AHA), and American Medical Association (AMA), recommend routine screening, especially to assist in identifying secondary causes of hypertension, such as renal disease. Therefore, the USPSTF essentially leaves blood pressure screening as a matter of clinical judgement (USPSTF, 2003).

Staging and Treatment

The Fourth Report has developed staging of BP according to the extent that the blood pressure exceeds the 95th percentile. This staging was proposed as a guide to assist in the most appropriate treatment for each individual patient. Stage 1 hypertension ranges from the 95th percentile to 5 mmHg greater than the 99th percentile. Stage 2 includes BP levels that are greater than 5 mmHg above the 99th percentile. Typically, stage 1 hypertension allows time for evaluation prior to initiating pharmacologic treatment. Those with stage 2 hypertension often need more prompt evaluation and pharmacologic therapy, especially if they are symptomatic. This staging

was designed with the intent to parallel the staging set forth by the JNC VII (NHBPEP, 2004).

Conservative reduction techniques are nearly always attempted initially in the management of adolescents with essential hypertension. The most commonly employed non-pharmacologic lifestyle changes include weight reduction in overweight individuals, dietary modification, regular physical activity, sodium restriction, elimination of caffeine, moderation of alcohol consumption, and smoking cessation.

As previously discussed, obesity has been shown to drastically impact the development of high blood pressure. Studies by Brownell et al. and Rocchini et al. have shown that weight loss can successfully lower blood pressure in many cases (Brownell, 1983 & Rocchini, 1988). Not only does weight loss lower BP, it also reduces other cardiovascular risk factors, such as insulin resistance and dyslipidemia. Unfortunately, weight loss is a very difficult achievement for many. Adolescents in the U.S. today are less likely to participate in physical fitness activities, and are more prone to sedentary behavior, such as watching television, spending time on the computer, and playing video games. The AAP currently recommends no more than 1-2 hours of television watching per day (AAP, 1995). Strategies aimed at reducing sedentary behavior should be discussed between the concerned clinician and the patient. Aerobic activity, such as walking, running, swimming, or cycling should be emphasized as the preferred method of exercise.

Cookies, chips, and fast food seem to have replaced fruits and vegetables as major dietary components for many adolescents. Based on the Food Guide Pyramid, increasing fresh fruit and vegetable intake, and whole grain consumption while

decreasing juice, refined carbohydrates, sweetened carbonated beverages, and saturated and trans fats will place individuals in a better position to optimize their overall health (Dietary Guidelines, 2000). A large percentage of adolescents would likely benefit from nutritional intervention by a specialist, possibly including counseling for the patient and their family.

The Fourth Report indicates when to initiate pharmacologic therapy in children and adolescents. Naturally, patients with secondary causes of hypertension should receive drug therapy. Also, those that are unresponsive to conservative treatment, patients with symptomatic essential hypertension, and those with established target-organ damage, should be strongly considered for pharmacologic therapy (NHBPEP, 2004). If treatment is initiated for adolescents with essential hypertension, the target BP should be <95th percentile for gender, age, and height. In those patients with co-morbid diseases such as diabetes, or renal disease, the ideal BP should be <90th percentile (NHBPEP, 2004). Many experts agree that adolescents with essential hypertension should be started on a single medication at the lowest recommended starting dose. If required, another agent with a complimentary mode of action can be added to the regimen. An example would be a diuretic prescribed with an angiotensin-receptor blocker.

Which drug to begin with remains a matter of preference for the prescribing clinician. Thus far, there have been no studies illustrating the long-term effects that antihypertensive medications may have on the overall health of patients beginning treatment at such a young age. Currently accepted classes of medications for this population include diuretics, angiotensin-converting enzyme (ACE) inhibitors,

angiotensin-receptor blockers, B-blockers, and calcium channel blockers (NHBPEP, 2004). Physicians should keep in mind that Beta-adrenergic antagonists (B-blockers) and diuretics are not typically the ideal antihypertensives for those patients concurrently attempting to lose weight through a relatively rigorous workout regimen. These two classes are actually banned by some sports organizations (Swain, 1997).

As the obesity epidemic continues to flourish in the United States, essential hypertension in the adolescent population will undoubtedly receive increased attention. The past several years have already seen several studies examining the efficacy of various antihypertensive medications in adolescent patients. A study by Ellis et al. examined use of the angiotensin-receptor blocker losartan, for treating children and adolescents with hypertension. Participants had either essential hypertension or hypertension secondary to renal disease. Losartan was found to provide adequate antihypertensive and renoprotective effects. Nearly all participants were within the normotensive range, even at the study follow-up at 2.42 years (Ellis, 2003).

Another study by Flynn et al. assessed Amlodipine, a dihydropyridine calcium channel blocker, in the treatment of children and adolescents with either primary or secondary hypertension. At the time of publication, this was the largest placebo-controlled clinical trial involving hypertensive children and adolescents. The study found that once daily Amlodipine significantly lowered systolic BP, and to a lesser extent diastolic BP, in hypertensive participants. Approximately 31% of those involved had primary hypertension. Ultimately, the underlying cause of hypertension had no influence on the response to the medication. Review of this study showed that only 34.6% of the participants achieved a reduction in systolic BP <95th%. The study offered

that subtherapeutic doses of Amlodipine were administered to the participants, and implied higher doses would produce more impressive results (Flynn, 2004).

One final study tested the ACE inhibitor lisinopril, as an antihypertensive in children ages 6-16 years. The study examined 115 randomized participants, grouped into one of three different dosage groups (high, middle, low). Their results showed an effective reduction in BP within 2 weeks in most patients (Soffer, 2002). As essential hypertension becomes an even greater problem in the adolescent population, other studies examining the efficacy of various antihypertensive medications will need to be accomplished in the near future.

The purpose of this study was to gain an understanding of current knowledge levels between pediatrician providers and non-pediatrician providers in detecting and appropriately treating adolescents (ages 12-17) with essential hypertension. The relevance of this study is associated with the increasing prevalence of obesity, and often subsequent increase in arterial blood pressure, among adolescents in the U.S. Based on research illustrating the harmful effects of long-standing essential hypertension, it would be simply unacceptable to fail in identifying and adequately treating patients in this population. As essential hypertension becomes a more common problem in adolescents, healthcare providers must be highly proficient in recognizing abnormal BP measurements, and knowledgeable with BP reduction methods.

Problem Statement:

Elevated arterial blood pressure among adolescents in the U.S. has become an area of significant concern due to increasing prevalence. Long-standing poorly-

controlled essential hypertension has been directly linked to very serious conditions including, heart disease, stroke, and kidney disease.

Research Hypothesis:

Pediatrician providers are more proficient than non-pediatrician providers in detecting and appropriately treating adolescents (ages 12-17) with essential hypertension.

METHODS

Review of Literature

Following the initial research proposal, pertinent literature was gathered utilizing internet search engines: Medline, Pub Med, CINAHL, and Google. All available articles were collected using various combinations of the keywords, adolescents, essential hypertension, obesity, metabolic syndrome, effects of long-standing hypertension, and treatment of adolescents with hypertension.

Survey Distribution

In our study, we designed an anonymous knowledge-based survey that was distributed to primary care oriented providers in the fields of family medicine, pediatrics, and emergency medicine. The survey was intended to aid in assessing knowledge levels of sampled healthcare providers regarding essential hypertension in the adolescent population (ages 12-17). We designed our survey questions based on the most recent guidelines set forth by JNC VII (2003) and The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (2004). Participants were asked to evaluate several hypothetical adolescent patients with essential hypertension. We attempted to assess their ability to accurately diagnose individuals with elevated BP. We also included questions pertaining to hypertension treatment options, and questions that helped elicit provider familiarity with current guidelines. A copy of the survey, along with appropriate responses for the knowledge-based portion, is shown in the appendix.

Following Institutional Review Board (IRB) approval, we hand-delivered our surveys to multiple ProMedica and Medical University of Ohio (MUO) locations,

beginning in June of 2005. Arrangements were made with office managers, enabling us to leave our surveys. Once finished, healthcare providers were asked to place completed surveys, without any identifying information included, into secure drop-boxes located at their individual clinical sites. Preliminary collections were conducted in early July. At the same time, courteous reminders were given to office managers at locations with poor turnouts to encourage providers to complete their surveys if they had not already done so. Final collections were carried out in early August 2005.

Participants

With the assistance of several healthcare providers and office managers at participating institutions, it was determined that a total of approximately 150 potential participants affiliated with ProMedica and MUO could be sampled for this study. As previously mentioned, participants had a background in family practice, pediatrics, or emergency medicine. Providers from these specialties were selected based on their potential for regularly encountering adolescents with essential hypertension in a primary care setting. Allopathic and Osteopathic physicians, physician assistants, and nurse practitioners comprised the spectrum of healthcare providers. No other exclusion criteria were used.

Statistical Analysis

All data analyses were performed using SPSS software. A one-way analysis of variance (ANOVA) was used for assessment of data. For post-hoc testing, Tukey's HSD was used to analyze differences in the knowledge mean scores based on type of practice. Statistical significance was defined as $P<0.05$.

RESULTS

Characteristics of Respondents

Table 1 summarizes the demographic data of the 43 respondents involved in this study. The total number of surveys distributed to potential participants was 150. Of those, 43 were returned at least partially completed. This resulted in a 28.6% return rate overall. Forty-nine percent of our respondents were male, while 51% were female. Thirty-three percent were under the age of 35, 47% were between 36 and 45, and the other 20% were greater than 45 years of age. Twenty-six percent had less than 2 years of experience in clinical practice, 37% had between 2 and 10 years of experience, and 37% had greater than 10 years of clinical experience. The majority of our participants held an M.D. (56%), while 7% were osteopathic physicians, 14% were physician assistants, 5% were nurse practitioners, and 19% were resident physicians (M.D. or D.O. not specified). Finally, there was a relatively even distribution among participants in all medical specialties sampled (see figure 1).

Healthcare Provider Knowledge Assessment

Of the 43 participants that submitted surveys, analysis of overall knowledge regarding essential hypertension in the adolescent population (ages 12-17) was assessed. The maximum possible score on the knowledge-based portion of the survey was a 13. Available demographic variables of the respondents were compared with overall scores on the quiz. Among age, gender, years in clinical practice, and the professional degree held, there were no significant differences ($P>0.05$) among healthcare providers. Interestingly, there was also no correlation between overall scores

on the quiz and the approximate percentage of patients seen by providers that fall within the range of 12-17 years.

There was, however, a significant finding between overall knowledge of adolescent hypertension and medical specialty [Reliability Coefficient of alpha=0.7800 (which indicates the stability of our measurements); $P<0.001$]. Individuals in emergency medicine performed at a much lower level on the hypertension quiz than those in family practice and pediatrics. Family practice providers scored just slightly lower than pediatric providers on the quiz. A comparison of mean scores on the survey between the three medical specialties can be seen in Figure 2.

Emergency medicine providers were largely unfamiliar with JNC VII standards regarding hypertension in the adolescent population (see Figure 3). They were also less likely to believe essential hypertension is a significant problem in adolescents (see figure 4). When resorting to pharmacologic intervention, participants showed significant diversity in the initial choice of medication (see Figure 5). This finding is not surprising based on the lack of scientific research indicating the overall best drug for use in this population (NHBPEP, 2004). Family practitioners did, however, show a strong preference for the usage of diuretics as a first-line agent.

DISCUSSION AND CONCLUSIONS

As mentioned earlier, essential hypertension in the adolescent population (ages 12-17) continues to increase in prevalence in the U.S. Our study looked at the knowledge levels of healthcare providers in a variety of settings pertaining to this topic. Results indicated, as we hypothesized, that pediatric providers, followed closely by family practitioners, are significantly more proficient than emergency medicine providers at detecting and treating adolescents (ages 12-17) with essential hypertension. The vast majority of emergency medicine providers sampled in our study were completely unfamiliar with JNC VII standards regarding detection and treatment of adolescents with essential hypertension. This is troubling since there are certainly different guidelines to follow when detecting and treating hypertension in adults as opposed to adolescents.

Essential hypertension in adolescents has become much more common than in previous decades partially due to sedentary lifestyle habits, and poor dietary choices (Cook, 2004). When the onset of essential hypertension is early in life, the detrimental effects this process has on the body inevitably begin at a premature age. It seems only logical that the major complications resulting from long-standing essential hypertension (heart disease, kidney damage, etc.) would occur at a much younger age as well. However, no long-term studies illustrating this theory have been conducted so far (Bao, 1995).

Emergency medicine providers are faced with a vast array of medical conditions on a daily basis. Understandably, these individuals cannot reasonably be expected to maintain a level of expertise comparable to that of family practitioners and pediatrician providers regarding essential hypertension in adolescents. However, abnormal vital

signs in any patient should be immediately recognizable to emergency medicine providers for obvious reasons. In any adolescent patient presenting with an elevated BP, this discrepancy must first be acknowledged as abnormal. Once an abnormal reading is documented, then subsequent measures can be taken. Secondary causes of hypertension should be ruled out. If no secondary cause is found, it is highly unlikely that pharmacologic treatment for presumed essential hypertension would be initiated in the emergency department, unless the reading was severely elevated, or there was evidence of end-organ damage (NHBPEP, 2004). Non-pharmacologic therapy could then be discussed briefly in the emergency department. Referrals to pediatric specialists could also be arranged if necessary.

Access to healthcare remains a burden for many in the U.S. As the number of uninsured continues to climb, people will turn more and more to emergency departments for their primary care needs. Providers in these settings must be skilled in recognizing elevated arterial pressures in any age group.

According to our results, conservative (non-pharmacologic) BP reduction methods are commonly recommended to patients by providers in all specialties. This is reassuring because the vast majority of adolescents (ages 12-17) with essential hypertension can be well-controlled with conservative measures alone (ATP III, 2001).

As mentioned earlier, experts have not yet determined a best first-line agent that should be used in the treatment of adolescents (ages 12-17) with essential hypertension. Currently, ACE inhibitors, Beta-Blockers, calcium-channel blockers, angiotensin-receptor blockers, and diuretics, are all approved as initial agents (NHBPEP, 2004). Our study participants showed a great deal of diversity in their

selection of first-line medications for adolescents. Family practice providers seemed to moderately favor administering a diuretic initially over any other prescription medication. There were no other obvious prescribing trends among specialties. As further studies indicating the efficacy and safety of various anti-hypertensive medications in this population are conducted, more specific guidelines pertaining to treatment will certainly be established.

Our study has several important limitations. First, our sample size was limited, obtaining an overall return rate of only 28.6%. Also, participants were selected only from Toledo area clinical settings. It is likely that results would vary significantly based on the geographic setting. For example, in parts of Arizona and Texas, where many illegal immigrants commonly use emergency departments as their only means of healthcare, clinicians may be more likely to prescribe anti-hypertensive medications than emergency providers in other locations (Associated Press, 2004). Secondly, the surveys were filled out in a non-controlled setting. As participants discovered that the survey tested knowledge of essential hypertension in adolescents, they may have referenced a pediatric blood pressure assessment chart. According to one individual that assisted in data collection for this study, many potential participants were reluctant to fill surveys out initially because they were unsure of the correct answers. A large percentage of people proceeded to take surveys home overnight for completion before turning them in. It is difficult to determine if this practice played a role in falsely elevating average scores in any of the groups sampled.

Future research could be well-served by sampling healthcare providers from a variety of geographic locations, rather than utilizing participants from only one city.

Also, as further studies illustrating the efficacy and long-term safety of anti-hypertensive medications used in adolescent populations are conducted, researchers could survey healthcare providers to ensure they are complying with the most recent treatment guidelines.

In conclusion, it is evident from our data that not all primary care providers are making their best effort to combat the current rise in adolescents (ages 12-17) with essential hypertension. While pediatrician providers and family practitioners performed relatively well on our knowledge-assessment survey, emergency medicine providers showed that there is certainly room for improvement. Again, emergency medicine providers function in an often chaotic setting. It is not expected that they become the foremost experts in all aspects of essential hypertension in adolescents. It is well known that treatment for essential hypertension would not likely be initiated in the emergency department for a number of reasons. However, emergency medicine providers must become familiar with current guidelines regarding hypertension in pediatrics and adolescents.

It is well-documented in scientific literature that long-standing essential hypertension is a major contributor to premature morbidity and mortality. As the incidence of obesity continues to grow in adolescents, essential hypertension will occur in even greater frequency within this population. Many of these individuals also have coexisting problems with dyslipidemia, and type 2 diabetes mellitus, to make matters worse. To prevent the major complications associated with essential hypertension from eventually occurring, healthcare providers must make a greater effort to correctly identify adolescents with abnormal BP measurements. Once detected and discussed

with patients and their families, appropriate reduction methods can be arranged as necessary. However, without recognition of an elevated BP, it is unlikely patients will be aware there is even a problem in need of fixing in the first place. As healthcare providers, especially those of us in primary care settings, we must pay particularly close attention to this growing problem. Physician assistants are in a unique position to contribute significantly in the battle against essential hypertension in the adolescent population. Maintaining proficiency in current detection and treatment guidelines is crucial to achieving success in preventing the harmful effects of long-standing hypertension in adolescents.

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Tables

Gender N= (%)	Male 21 49%	Female 22 51%			
Age of respondents (in years) N= (%)	Less than 35 14 33%	36-45 20 47%	46-55 8 19%	56 or greater 1 2%	
Total number of years in practice N= (%)	Less than 2 11 26%	2-10 16 37%	11-20 10 23%	21 or greater 6 14%	
Level of training N= (%)	MD 24 56%	DO 3 7%	PA 6 14%	NP 2 5%	Resident Physician 8 19%
Medical Specialty N= (%)	Family Practice 16 37%	Pediatrics 17 40%	Emergency Medicine 10 23%		

Table 1. Demographic characteristics of participants involved in study.

Figures

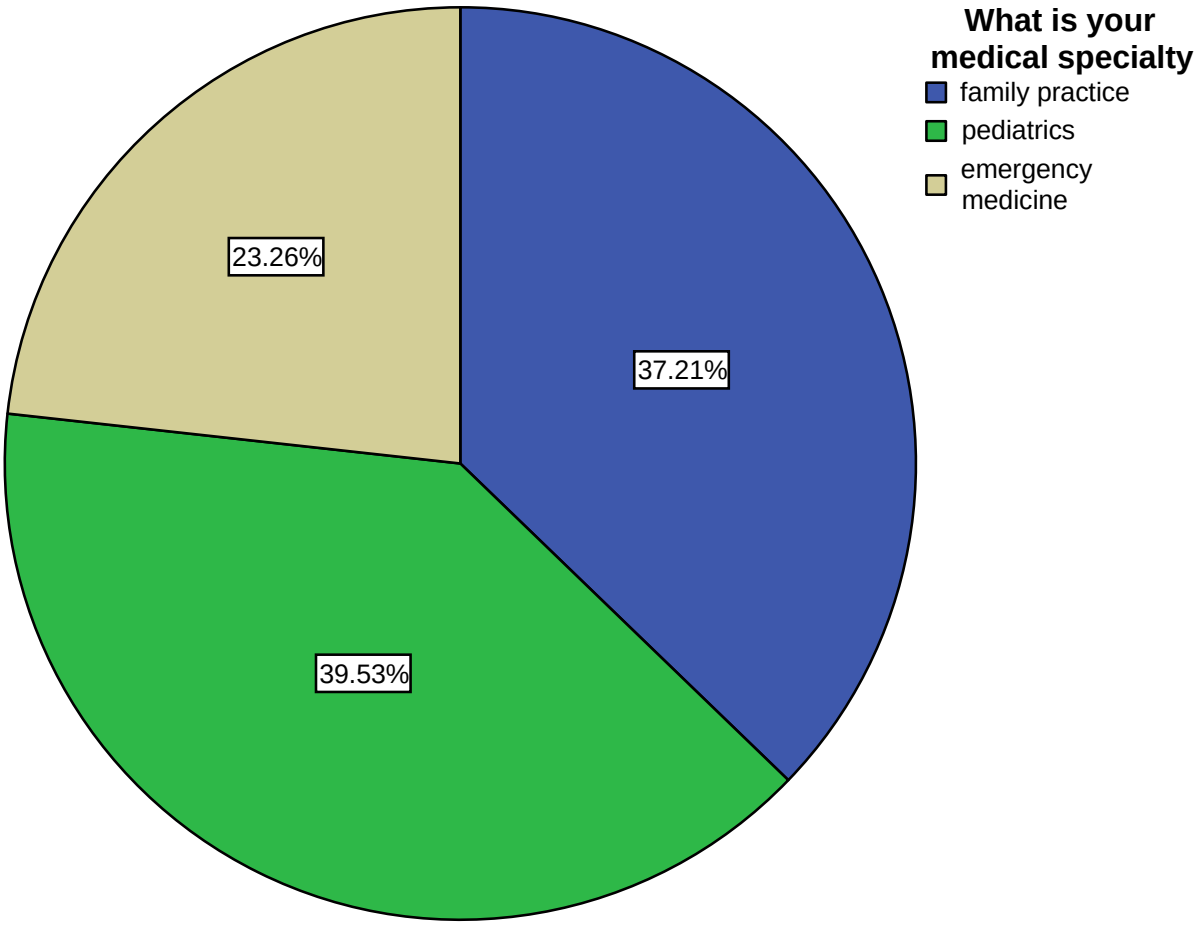

Figure 1. Breakdown of study participants by medical specialty.

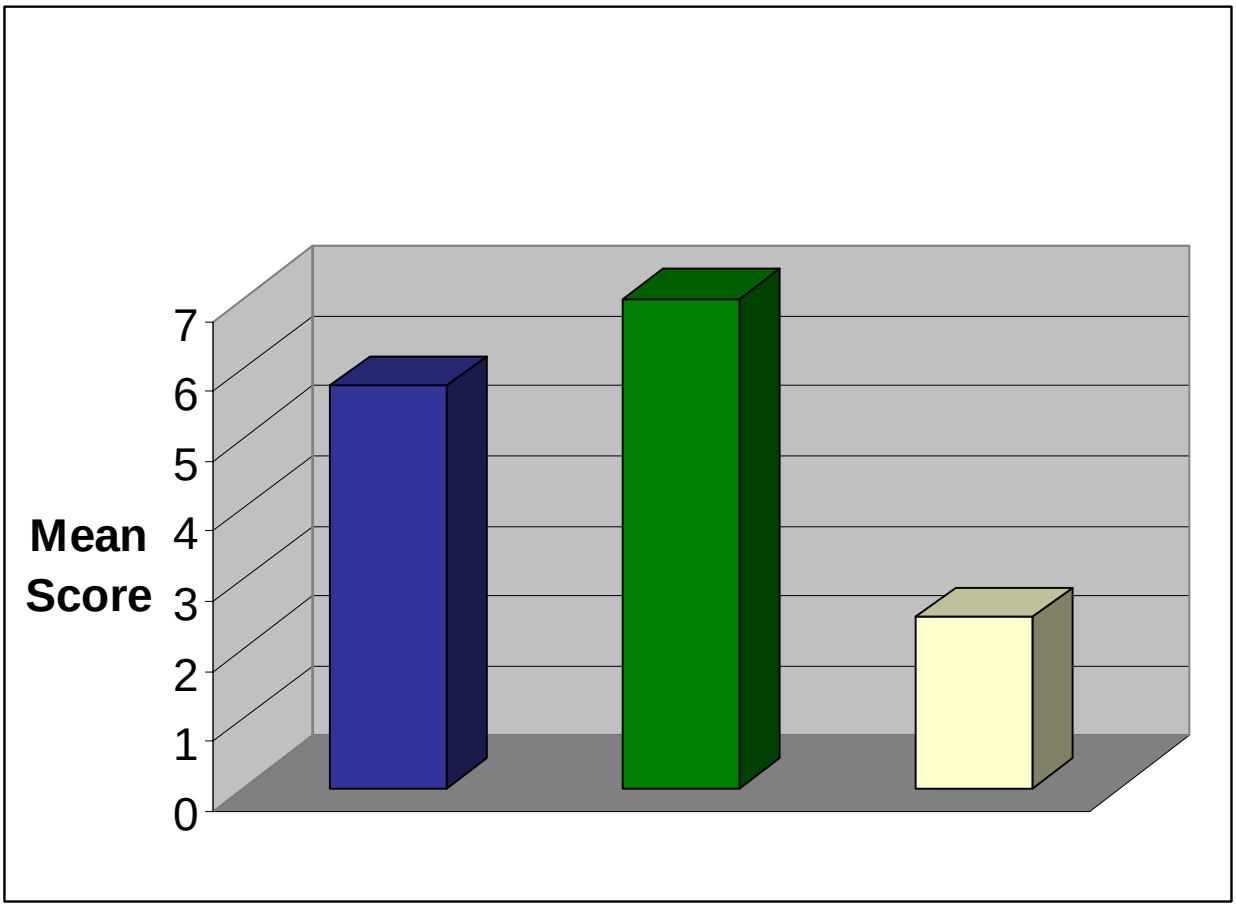

Figure 2. Mean Score on Hypertension Knowledge Assessment Survey by Medical Specialty. Maximum score was a 13.

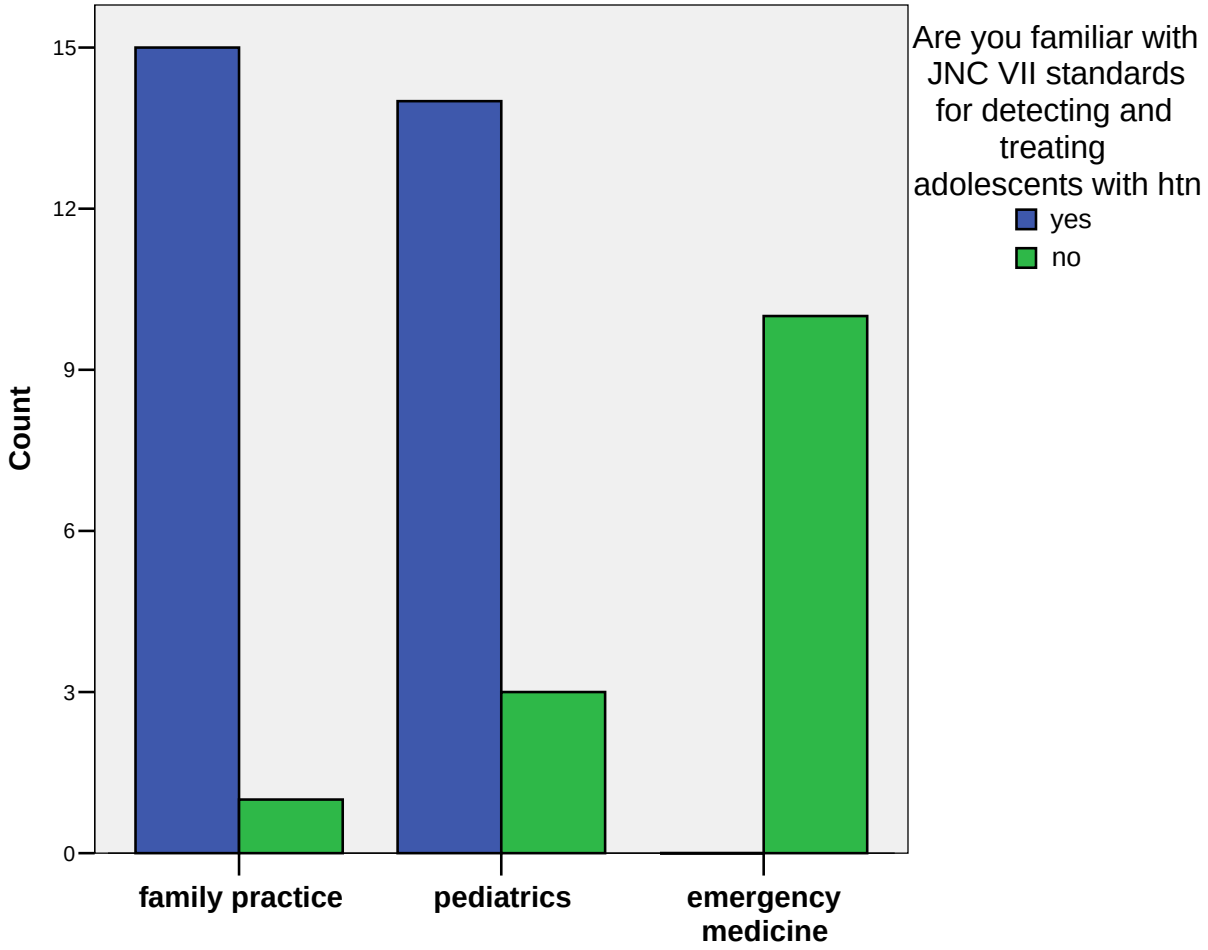

Figure 3. Familiarity with JNC VII standards by medical specialty.

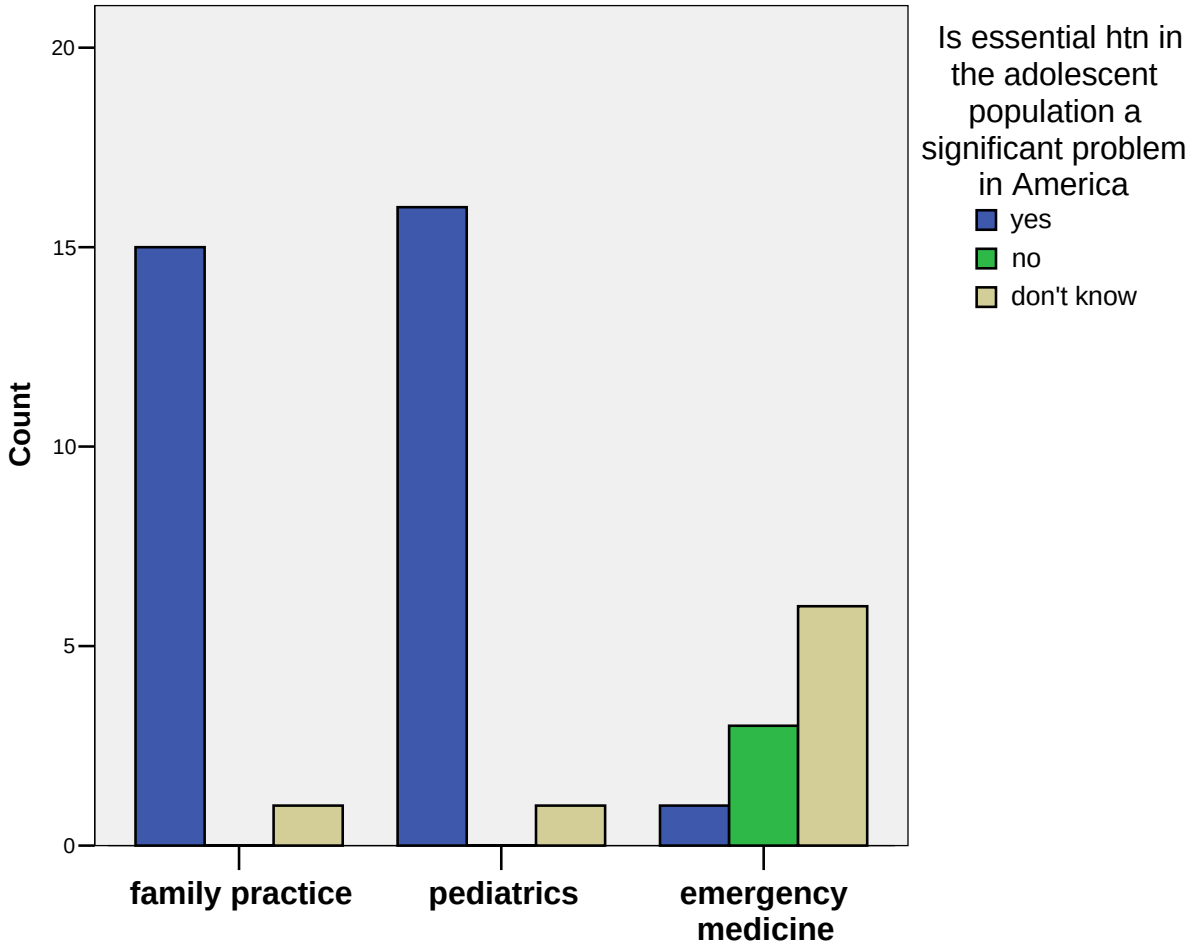

Figure 4. Belief among medical specialties regarding the significance of essential hypertension in adolescents (ages 12-17).

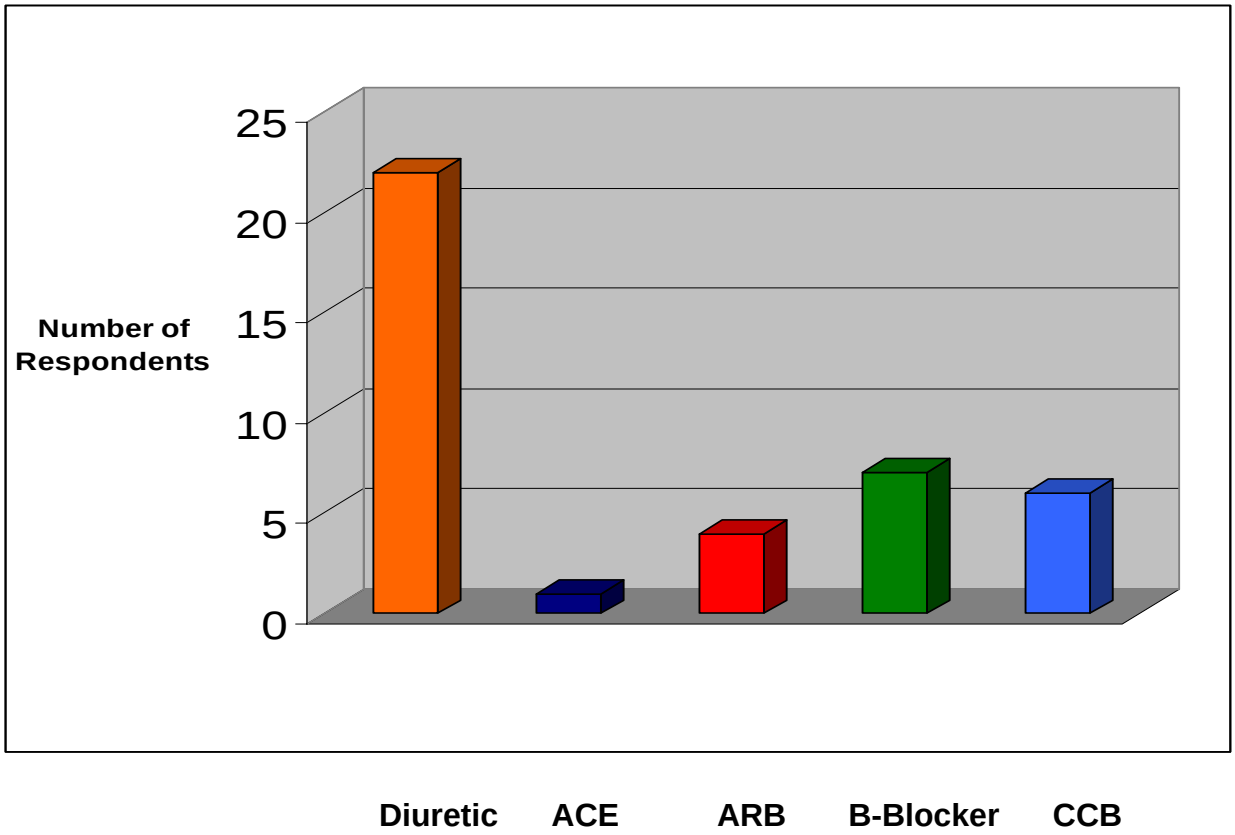

Figure 5. Pharmacologic treatment of choice among study participants for adolescents (ages 12-17) with essential hypertension. ACE; angiotensin-converting enzyme inhibitor, ARB; angiotensin-receptor blocker, CCB; calcium-channel blocker.

Appendix

1. What is your gender?
   ☐Male ☐Female

2. What is your age?
   ☐<35 ☐56-65
   ☐36-45 ☐>65
   ☐46-55

3. How long have you been in clinical practice?
   ☐<2 yrs ☐16-20 yrs
   ☐2-5 yrs ☐21-25 yrs
   ☐6-10 yrs ☐>25 yrs
   ☐11-15 yrs

4. Select the appropriate level of medical training.
   ☐M.D. ☐P.A. ☐Resident Physician
   ☐D.O. ☐N.P.

5. Select your medical specialty.
   ☐Family Practice ☐Emergency Medicine
   ☐Pediatrics ☐Other

6. Please select the approximate percentage of patients aged 12-17 years you see throughout an average week.
   ☐< 10% ☐51-75%
   ☐11-25% ☐76-100%
   ☐26-50%

7. How often are adolescent patients (ages 12-17) you see screened for high blood pressure?
   X☐Every visit ☐Every well-visit only ☐Every sick-visit only ☐B.P is not routinely checked

8. Who performs blood pressure measurements on patients you see in your practice?
   ☐I always check B.P. myself
   ☐I often check B.P myself (an assistant **sometimes** does)
   ☐I rarely check B.P myself (an assistant **almost** always does)
   ☐I never check B.P. myself (an assistant **always** does)

9. Are you familiar with the Seventh US Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) standards regarding the management of children and adolescents with high blood pressure?
   X☐Yes
   ☐No

10. If you are familiar with the national guidelines (JNC 7) where did you learn about them?
    ☐Professional journal ☐CME lecture ☐From a colleague ☐Unfamiliar
    ☐Internet website ☐Medical text ☐Other

11. Is essential hypertension in the adolescent population (ages 12-17 years) a significant problem today in America?
    X☐Yes ☐No ☐Don't Know

12. What is the minimal systolic blood pressure considered hypertensive in a 13 year-old adolescent male of average height?

☐112 mmHg X☐126 mmHg
☐120 mmHg ☐131 mmHg

13. What is the minimal diastolic blood pressure considered hypertensive in a 13 year-old adolescent male of average height?

☐70 mmHg X☐81 mmHg
☐76 mmHg ☐90 mmHg

14. What is the minimal systolic blood pressure considered hypertensive in a 16 year-old adolescent female of average height?

☐120 mmHg ☐134 mmHg
X☐128 mmHg ☐140 mmHg

15. What is the minimal diastolic blood pressure considered hypertensive in a 16 year-old adolescent female of average height?

☐80 mmHg ☐87 mmHg
X☐84 mmHg ☐90 mmHg

16. According to JNC VII standards, should gender be considered when measuring blood pressure in adolescents?

X☐Yes ☐No ☐Don't Know

17. What non-pharmacologic (conservative) methods do you normally suggest to your adolescent patients (ages 12-17 years) with essential hypertension? (Please choose all that apply)

☐Weight loss (if needed) ☐Smoking cessation
☐Dietary modifications ☐Meditation
☐Salt restriction ☐Yoga
☐Aerobic exercise ☐Other At least 1 box marked counted as a correct answer

18. Guidelines set forth by the JNC VII for when to initiate pharmacologic therapy in adults with essential hypertension are the same as the guidelines for initiating treatment in adolescents.

☐Yes X☐No ☐Don't Know

19. When would you initiate pharmacologic treatment for a 16 year-old adolescent male with documented essential hypertension on three separate visits, who is also unresponsive to conservative therapy? Please choose a **systolic** blood pressure.

☐130 ☐150 ☐>160
X☐140 ☐160

20. When would you initiate pharmacologic treatment for a 16 year-old adolescent male with documented essential hypertension on three separate visits, who is also unresponsive to conservative therapy? Please choose a **diastolic** blood pressure.

☐80 ☐90 ☐>95
X☐85 ☐95

21. What would be your first line of pharmacologic treatment for an adolescent with essential hypertension?

X☐Diuretic ☐Alpha Adrenergic Antagonist
X☐ACE Inhibitor X☐Beta Adrenergic Antagonist
X☐Angiotensin Receptor Blocker X☐Calcium Channel Blocker
☐Diuretic/ Potassium-sparing diuretic ☐Beta-Blocker/ Diuretic
☐ACE Inhibitor/ Diuretic ☐Angiotensin Receptor Blocker/ Diuretic

Abstract

Objective. The goal of this study was to assess the proficiency of primary care providers in detecting adolescents (ages 12-17) with essential hypertension. We also looked at treatment preferences, and familiarity with national guidelines regarding hypertension in the adolescent population. **Methods.** A knowledge-based survey was administered to approximately 150 healthcare providers in the fields of family practice, emergency medicine, and pediatrics throughout the Toledo area. **Results.** There was a significant finding between overall knowledge of adolescent hypertension and medical specialty ($P<0.001$). Individuals in emergency medicine performed at a much lower level on the hypertension quiz than those in family practice and pediatrics. Family practice providers, however, performed at a level just slightly below pediatrician providers. **Conclusion.** To prevent the major complications associated with essential hypertension, healthcare providers must make a greater effort to correctly identify adolescents with abnormal BP measurements. Once detected, appropriate reduction methods can be arranged as necessary.