IMPROVING THE DETECTION OF HYPERTENSION IN PEDIATRIC AMBULATORY VISITS

A Thesis submitted to the University of Arizona College of Medicine -- Phoenix
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Dedication

I dedicate this project to my family and friends, who supported me unconditionally throughout medical school.

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ABSTRACT

Background and Significance

The prevalence of pediatric hypertension (HTN) has increased in the past several decades and is projected to continue to rise.[2] Because normal blood pressure (BP) values in children depend on age, sex, and height, HTN is difficult to recognize. If not diagnosed during childhood, HTN poses several long-term health risks.[4,10] Electronic medical records (EMR) have tools to help recognize elevated BP in children. Unfortunately, many clinicians are unaware of these support tools, and pediatric HTN is underdiagnosed.

Research Question

This study is designed to improve the detection of HTN in children.

Methods

This is a prospective quality improvement (QI) study completed at a teaching institution with rotating physicians. We reviewed the charts of 1697 children aged 3 to 18 years who were seen by physicians for well-child visits in March, June, July, August, November 2014, and January 2015. We recorded children with elevated BP and determined if HTN was recognized (noted in the assessment/plan or BP repeated). We used March as our baseline detection rate and completed five interventions, one before each month. All interventions consisted of PowerPoint presentations for medical personnel (physicians, nurses, medical assistants). The last two interventions consisted of a change in the EMR (BP percentiles displayed in a summary page) and signs hung in the clinic. Pre- and post-intervention data underwent analysis, and we examined factors that may impact early detection of HTN.

Results

Of the 1697 children, 188 (11.1%) had elevated BP. The prevalence of elevated BP declined from the pre-intervention month to post-intervention months (March 13.5%, June 10.3%, July 9.7%, August 9.2%, November 12.5%). The prevalence returned to baseline by January (13.5%). The recognition of elevated BP improved from 25% in March to 44% and 55% in June and July,

respectively. There was a decline in detection from July to August and November (55% to 41% and 35%). There was improved detection again from November to January (35% to 48%). Factors that increased the detection of HTN were obesity (χ^2=22.9, p=0.000002), systolic BP $\geq$120 (χ^2=8.1, p=0.0045), and a past history of elevated BP (χ^2=5.1, p=0.024).

Conclusions

Our educational interventions improved the absolute detection of HTN. Repetition of interventions and involvement of the whole care team were important for sustaining the improvements, especially for a teaching institution with rotating physicians. Repeated interventions may not be necessary for private practice clinics. The improved detection correlated with a steady decline in the prevalence of HTN, probably related to blood pressures that were falsely elevated due to patient anxiety and incorrect cuff sizing. Obesity, systolic BP$\geq$120, and past history of at least one elevated BP significantly improved the detection. This QI project was not intended to determine the efficacy of each intervention, but rather to improve the detection rate as a whole. We cannot conclude whether the monthly changes were due to chance, but we can conclude that we improved the overall detection.

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INTRODUCTION

Hypertension occurs in two to five percent of children.[1] The prevalence of pediatric hypertension has increased dramatically in the past several decades and is projected to increase further.[2] The American Academy of Pediatrics and The National Heart, Lung, and Blood Institute recommend assessing blood pressure at every visit in children over three years old.[1,2,4] Because normal blood pressure values in children depend on age, sex, and height, it can be difficult to recognize abnormal values in this population, and elevated blood pressures in children are often overlooked. In one study, hypertension was diagnosed in only 26% of children with elevated blood pressures.[8]

Hypertension is defined as blood pressure at or above the ninety-fifth percentile for a child's age, sex, and height, measured on three separate occasions.[4] The diagnosis of hypertension in a child warrants a thorough work-up to rule out underlying medical conditions. Children with elevated blood pressure should also be screened for risk factors for cardiovascular disease, including diabetes mellitus and hyperlipidemia.[4]

If undiagnosed in childhood, hypertension poses several long-term risks. Hypertensive children should be evaluated for target organ damage, including left ventricular hypertrophy, diastolic dysfunction, and increased carotid artery thickness.[4,10] One study determined that 41% of newly diagnosed children showed left ventricular hypertrophy. Hypertension in childhood is a risk factor for hypertension in adulthood, the leading cause of premature death worldwide.[4,12] Therefore, it is important to diagnose hypertension early and screening should be strongly encouraged.

Medical providers often miss detecting hypertension in children. Providers do not measure blood pressure in two-thirds of routine visits and one-third of preventive visits.[1] When blood pressures are recorded during ambulatory visits, hypertension is often missed. Elevated blood pressures are detected more frequently in the presence of obesity (BMI >30), older age (13-18

years), blood pressure ≥120/80 (adult hypertension), and family history of cardiovascular disease.[1,2,8] However, in the absence of these factors, hypertension is often undetected.

Long-term solutions for improved identification of pediatric hypertension may include electronic medical record clinical decision support tools.[5] One study demonstrated that a simplified blood pressure table accessible to clinicians could improve detection of hypertension in children.[3] Similarly, a clinical support algorithm built into an electronic medical record could review vital information and alert the clinician of an abnormal blood pressure.[7] Alternatively, the electronic medical record clinical decision support tool could calculate blood pressure percentiles and display these values to alert the clinician of abnormalities.[4]

It is important to increase awareness of the diagnosis of hypertension in children.[8] If we increase knowledge about the importance of early detection of hypertension and the utility of clinical decision support tools in electronic medical records, hypertension may be detected and diagnosed more appropriately. Ultimately, this may decrease long-term morbidity and mortality in children.

RESEARCH MATERIALS AND METHODS

Design

We performed a quality improvement project with five cycles of intervention, in order to improve the detection of pediatric hypertension in our population.

During all six months, we determined whether elevated blood pressures were recognized by medical personnel (physicians, nurses, medical assistants). We defined detection of hypertension by at least one of the following: a note in the assessment or plan about elevated blood pressure, a diagnosis of hypertension or elevated blood pressure, a repeat blood pressure taken during the visit, or a request for a follow-up visit for elevated blood pressure. We used March as our baseline detection rate and completed interventions before each month starting June 2014. We collected data for five specific months post-intervention (June, July, August, November, January) for this study. We aimed to increase detection of hypertension after each intervention.

Prior to data collection and interventions, the study was exempted from review by the Institutional Review Boards of Maricopa Integrated Medical System and the University of Arizona.

Subjects

We reviewed the charts of all children aged 3 to 18 years who were seen by physicians for well-child visits (N = 1697) in an outpatient community health center serving predominantly Hispanic populations in Phoenix, Arizona. We recorded all children with elevated blood pressures (N = 188) during the months of March, June, July, and August, November 2014, and January 2015. Patients with preexisting renal or cardiac problems were excluded from the study.

Interventions

We delivered the same 10 minute PowerPoint presentation to five separate audiences. The first presentation was given to nurses and resident physicians rotating in the clinic for the month.

The second presentation was given to nurses, resident physicians rotating for the month, and resident physicians who worked one to two half-days per week (continuity clinic residents). The third presentation was given only to the next set of resident physicians rotating in the clinic for the month of August. The fourth intervention included a presentation for resident physicians rotating for the month plus a change in the electronic medical record (BP percentiles displayed and highlighted in a tab summarizing important patient information). The fifth intervention consisted of a presentation for resident physicians rotating in the clinic for the month, an EMR change, and paper signs hung in the clinic to encourage checking BP values.

The PowerPoint presentations provided information on the prevalence and definition of hypertension in children and the recommendations for screening children according to The American Academy of Pediatrics and the National Heart, Lung, and Blood Institute. Additionally, we stressed that elevated blood pressure in children is widely underdiagnosed, which poses long-term health risks to children. We presented the clinic's baseline rate of detection of hypertension (25%) with the intention of improving this during the subsequent months. We educated the audience about tools within the electronic medical record that highlight abnormal BP percentiles. Furthermore, we discussed how to correctly measure, size, and place blood pressure cuffs for children.

Data Collection

Visit information including age, sex, race, height, weight, body mass index (BMI) number, BMI percentile, BMI classification, blood pressure, blood pressure percentile, detection of elevated blood pressure, and past medical history of hypertension (at least one BP>95%ile) were noted in a spreadsheet. Data from this spreadsheet were used for analysis.

Data Analysis

Our main outcomes in the study were number and percentage of hypertensive children who were recognized as having elevated blood pressures during well-child exams. We compared data from the pre-intervention month (March) to each post-interventional month (June, July,

August, November, January) using a run-chart. In addition, we estimated the prevalence of elevated blood pressures in children for each month of data collected.

We grouped the patients according to the presence or absence of three criteria: obesity, previous elevated blood pressure, and systolic BP$\geq$120. Independent of our interventions, we analyzed the importance of these three variables in relation to the detection of hypertension by Chi-Square analysis.

RESULTS

Demographics

82% of our study population was Hispanic. 47% were male, and 53% were female. Majority of the patients were ≤ 12 years in age (96%), and 50% of the patients were 3 to 6 years old.

Prevalence of Elevated Blood Pressure

The prevalence of elevated blood pressure for our study was 11.1%, higher than expected (2-5% in the literature[1]). Interestingly, the prevalence of elevated blood pressure declined from the pre-intervention month to post-intervention months (March 13.48%, June 10.31%, July 9.69%, August 9.21%, November 12.5%). The prevalence returned to baseline by January (13.5%), as shown in Figure 1.

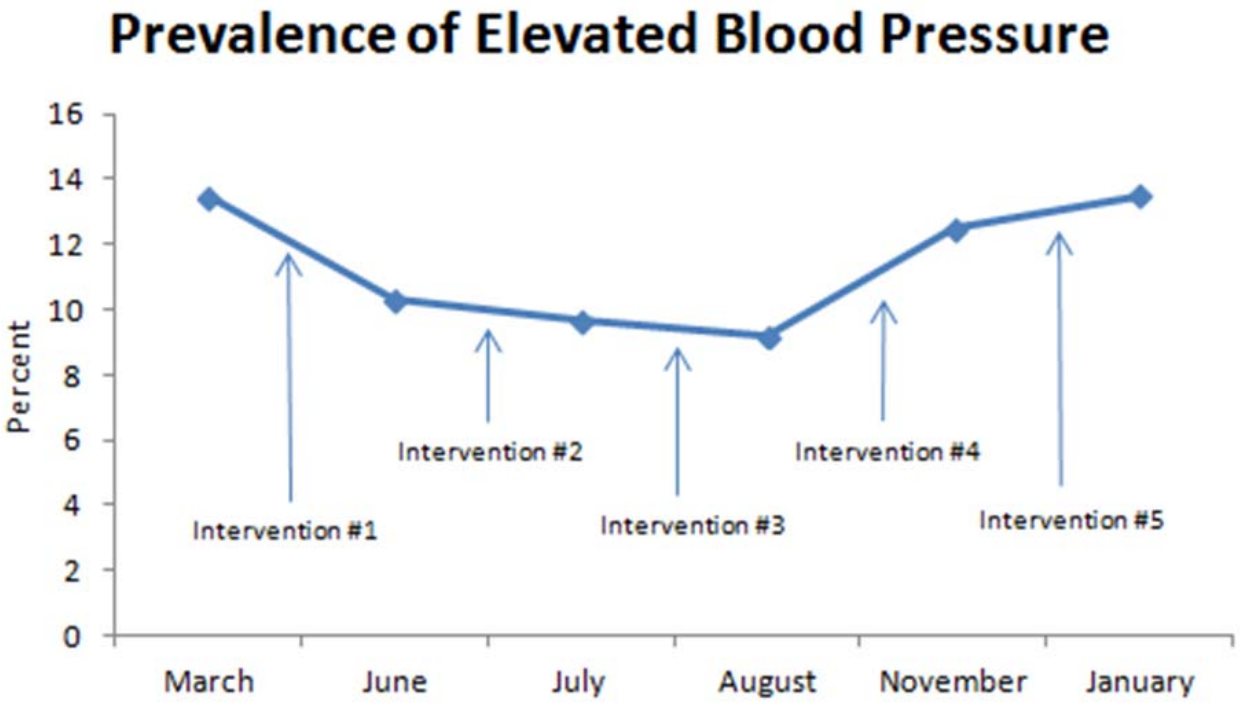

Figure 1. The prevalence of hypertension was not statistically different between the five sampling periods.

Detection of Elevated Blood Pressure

When comparing March to each post-intervention month, the absolute detection of hypertension improved. Combining June, July, August, November, January and comparing it to March, the detection of hypertension improved from 25% to 46% in total.

The recognition of elevated blood pressure improved from 25% in March to 44% and 55% in June and July, respectively. There was a decline in detection from July to August and November (55% to 41% and 35%). There was improved detection from November to January (35% to 48%), as shown in Figure 2. Table 1 shows a summary of our interventions and results.

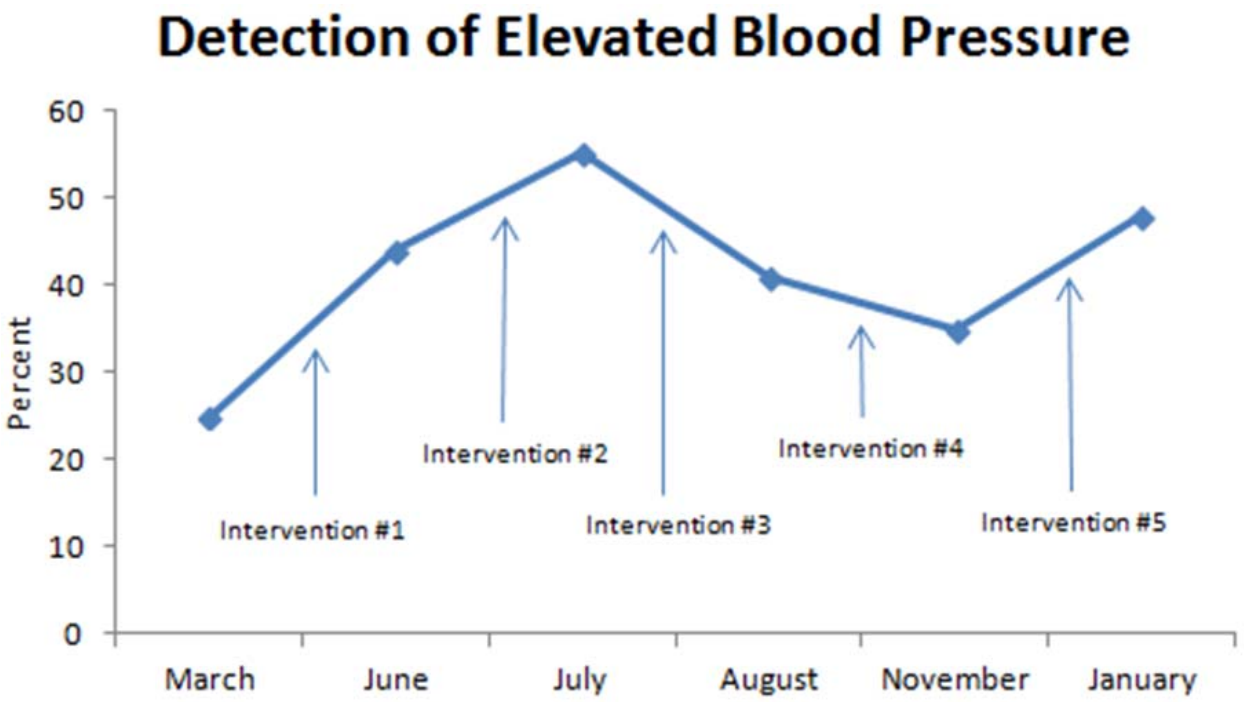

Figure 2. Detection of hypertension in periods two through five was statistically above the baseline rate in period one.

Table 1. Summary of Interventions and Results

Cycle	Intervention	Well Child Checks (#)	Prevalence of Elevated Blood Pressures	Detection of Elevated Blood Pressures
Baseline (March)	---	267	13.5%	25%
Cycle 1 (June)	Education: General Clinic, Nurses	262	10.3%	44%
Cycle 2 (July)	Education: General Clinic, Continuity Clinic, Nurses	454	9.7%	55%
Cycle 3 (August)	Education: General Clinic	315	9.2%	41%
Cycle 4 (November)	Education: General Clinic EMR Change	184	12.5%	35%
Cycle 5 (January)	Education: General Clinic EMR Change Clinic Signs	215	13.5%	48%

Obesity

Irrespective of our interventions, we discovered that obesity increases the overall detection of hypertension (χ^2=22.9, p=0.000002). 38% of our patient population was obese, and the majority (64%) of these children were recognized correctly with hypertension. The detection of elevated blood pressure in obese children increased from 45% in March to 60% in June, 74% in July, 67% in August, 75% in November, and 55% in January.

Systolic Blood Pressure $\geq$120mmHg

We expected that systolic BP$\geq$120 would be more easily recognized because it represents adult-range hypertension. 47% of our patients' systolic blood pressures were $\geq$120. The presence of systolic blood pressures $\geq$120 was associated with an increase the detection of hypertension (χ^2=8.1, p=0.0045).

Previous History of Elevated Blood Pressure

51% of our patients had a history of at least one elevated blood pressure. Outside of our interventions, the presence a previous elevated blood pressure improved the overall detection of hypertension (χ^2=5.1, p=0.024).

DISCUSSION

Our five interventions improved the absolute detection of elevated blood pressure in children. The detection rate notably improved after the initial interventions (June and July) most likely because the audiences were large (nurses and two groups of resident physicians). The detection rate declined in August presumably because the audience was small (one group of resident physicians). The audience was small during this intervention because we assumed that all clinic nurses as well as resident physicians had already listened to our presentation. Unfortunately, old habits returned and the detection rate did not continue to rise after the third intervention. This suggests that repetition and whole clinic synergy is an important factor for improving detection of elevated blood pressure in pediatric populations.

After recognizing the August decline, we decided to expand the intervention for the subsequent month (November) to PowerPoint presentation plus an EMR change. Unexpectedly, this resulted in a further decline in detection rate for November. In hopes of improving the detection rate for January, we continued the educational presentations, which emphasized the EMR change, plus we hung signs in the clinic about checking BP values. Interestingly, the three together improved the detection rate to 48%.

Additionally, during the first educational presentation, several nurses pointed out that the electronic medical record (EMR) alerted them when recorded blood pressure values were out of range. Other medical providers were not aware that these EMR tools were in place. We encouraged nurses to pay close attention to these alerts and repeat blood pressures when alerted. This may have added to the improvement of detection of hypertension during June and July, the two months showing the most improvement.

Improved detection rates correlated with declines in the prevalence of pediatric hypertension. This is most likely due to the interventions before each month. In addition to providing information about pediatric hypertension and electronic medical record tools, the PowerPoint presentation emphasized the importance of correctly sizing and placing blood pressure cuffs.

This information is particularly important for obese children, as blood pressure is falsely elevated if the cuff is too small. In addition, the decline in prevalence could be correlated to blood pressures that are initially elevated secondary to anxiety from being in a doctor's office. Upon repeat examination, these BP values were often lowered to normal after some time.

Our estimated total number of patients with elevated blood pressures is higher than compared to other literature sources[1,2] most likely due to population differences and incorrect cuff sizing. Repeating the blood pressure to account for initial anxiety in children and placing correct blood pressure cuffs may be the reason for this variability in prevalence over time in our study. Fortunately, the interventions began to correct the overestimation and the prevalence of hypertension declined when the detection rate improved.

As in other studies[1,2,8], obesity increased the overall detection of elevated blood pressure in children. Fortunately, this means that our interventions helped recognize high risk patients.

Systolic blood pressure $\geq$120 also increased the detection of high blood pressure. This is expected because blood pressure review is important in adults, and an adult blood pressure above this level would be noted by most physicians.

It is particularly important to recognize patients with previous elevated blood pressures because of the associated long-term health consequences[4,10]. A previous history of elevated blood pressure did increase the detection of hypertension in our study. Since the study improved the recognition of elevated blood pressures after educational interventions, we were able to recognize more patients with previously elevated blood pressures, which may have health benefits for these children.

In summary, educational interventions should target all staff and providers in order to maximally improve the detection of hypertension. Repetition may also improve the outcomes, especially in a teaching facility with rotating physicians. This quality improvement project was

not intended to determine the efficacy of each intervention, but rather to improve the detection rate as a whole. We cannot conclude whether the monthly changes were due to chance, but we can conclude that we improved the overall detection.

FUTURE DIRECTIONS

After completion of this study, we plan to continue with the interventions in the clinic to maintain the improved detection rates. The clinic already has planned an ongoing monthly educational PowerPoint presentation that will at least be given to residents rotating in the clinic for the month. The presentation includes screen shots of EMR tools and education about hypertension in children and correct cuff sizing. Fortunately, the EMR tool shown in the presentation has been moved to a more prominent location in the EMR to decrease the number of clicks to reach it. We will continue to post signs around the clinic with information about checking BP values regularly. We will also continue to educate the clinic as a whole about the importance of HTN in children.

CONCLUSIONS

Pediatric hypertension is a prevalent, asymptomatic condition that should be diagnosed early. Simple interventions, like education, electronic medical record tools, proper blood pressure cuff sizing and placement, and signs in the clinic can improve the overall recognition of elevated blood pressures in pediatric populations. Pediatricians, in general, do not make checking blood pressure a habit. Our study demonstrates the importance of repeated, whole-clinic interventions in order to be successful in a teaching facility with rotating physicians.

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