Hypertension screening and follow up in children and adolescents in a Canadian primary care population sample

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Abstract

Background: Uncertainty exists about the need to screen for hypertension in children and adolescents. Recognizing an abnormal blood pressure (BP) is difficult because this changes with age, sex and height. There are no studies on rates of paediatric hypertension screening and follow up in Canada.

Methods: We used Electronic Medical Record data from seventy-nine family practices in Toronto, Canada. We identified children seen at least twice between the ages of 3 and 18 years, with at least six months between first and last encounter. We used Multivariate Poisson regression analysis to analyze variation in blood pressure measurement rates and associations with patient and physician factors.

Results: 9,667 children were included. 5,996 (62%) had at least one BP recorded. 14% of patients whose BP centiles could be calculated had at least one abnormal BP; only 5% of these patients had a follow up BP recorded within 6 months. After adjustment, increases in rates of recorded BP measurements were associated with greater number of encounters (Rate Ratio [RR]=1.03, 95% CI 1.02-1.04, p<0.0001), older age at first encounter (RR=1.06, 1.03-1.10, p=0.0002), and female sex (RR=1.12, 1.03-1.20, p=0.006). Obesity or a recorded family history

of hypertension were not associated with the rate of recorded BP. Female physicians recorded more BPs (RR=1.41, 1.04-1.89, p=0.02).

Interpretation: Although two-thirds of children had their BP measured at least once, few had timely follow up for abnormal results. Risk factors such as obesity or a recorded family history of hypertension were not associated with more BP measurements in children.

Key words: children, adolescent, hypertension, screening, Canada, primary care

Introduction

The estimated prevalence of hypertension in children and adolescents is 1-5%.[1] The prevalence of this condition is rising concurrently with the increase in the rates of obesity and metabolic syndrome in children and youth.[2]

In 2004 the United States National High Blood Pressure Education Program (NHBPEP) Working Group on High Blood Pressure in Children and Adolescents published guidelines for screening, diagnosis and classification of hypertension in children and adolescents.[3] They recommended the measurement of blood pressure (BP) during every health care episode.[3] This was reviewed and endorsed for children between 3 to 18 years of age in 2011.[4] In 2009, the European Society of Hypertension recommended that children above 3 years of age have their BP measured.[5] In 2010, the Canadian Paediatric Society published the Greig Health Record, an evidence-based health promotion guide for Canadian clinicians caring for children and adolescents aged 6 to 17 years. Periodic blood pressure measurement was recommended, based on “fair evidence”.[6] The 2014 Rourke Baby Record, endorsed by the College of Family Physicians of Canada and the Canadian Paediatric Society, guides well baby and child visits up to age 5 and recommended BP measurement starting at age 2, based on “fair evidence”.[7]

In 2013, the US Preventive Services Task Force (USPSTF) issued an "I" (insufficient evidence) recommendation for screening for hypertension in children and adolescents.[8] They found no evidence that screening detected children at higher risk of cardiovascular outcomes; evidence that treatment of paediatric hypertension prevented adverse health outcomes was inadequate.[8] There are no recommendations from the Canadian Task Force on Preventive Health Care or from the Canadian Hypertension Education Program regarding children. There is therefore uncertainty about the need to measure BP in asymptomatic children.

BP evaluation in children and adolescents includes stratification of hypertensive category using age, sex and height. Normal BP is considered to be a value less than 90th percentile for age, sex, and height. Prehypertension is defined as BPs between the 90th and 95th percentile or greater than120/80 mmHg.[1] The diagnosis should be confirmed with additional measurements and then repeated within 6 months. About 7% of children and adolescents with prehypertension will progress to hypertension every year.[9] A BP equal to or greater than the 95th percentile is defined as being consistent with hypertension. Stable hypertension should be monitored at least every six months. Therefore, an abnormal reading should be repeated within a maximal interval of six months.

The strongest risk factor for paediatric hypertension is obesity; other factors include a family history of hypertension and male sex.[8] In the U.S., blood pressure measurements are done during 35% of paediatric visits; BPs are measured more often if the child is obese.[10] To our knowledge, there are no studies describing primary care screening for paediatric hypertension and follow up of abnormal blood pressures in Canada.

The objective of this study is to describe hypertension screening in children and adolescents and follow up after an initial abnormal reading in a Canadian urban primary care population sample. We also describe patient and provider factors associated with blood pressure screening.

Methods

Data Sources and Study Population

This was a retrospective observational study. We used data from seventy-nine primary care providers practicing in or around Toronto, Canada and participating in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) as part of the University of Toronto Practice Based Research Network (UTOPIAN). Most providers were family physicians; one provider was a nurse practitioner. CPCSSN is Canada's first multi-disease Electronic Medical Record (EMR) based surveillance system.[10] UTOPIAN is one of ten networks currently participating in CPCSSN and is a primary care practice based research network affiliated with the Department of Family and Community Medicine at the University of Toronto. Data were extracted from three different EMR software applications (Nightingale-on-Demand®, Practice Solutions® and Bell EMR®).

The study population included all patients flagged as being enrolled (or rostered) to the practice and indicated as being active (non-transient) in the EMR as of April 1st, 2013. All encounters recorded when a patient was between 3 and 18 years of age were extracted. Encounters recorded in the EMR can include phone or email encounters; these were excluded. We only included office visits, since there was an opportunity to measure blood pressure at the office during those encounters. The study sample included children and adolescents with a minimum of two office

visits with at least six months between the first and last visit recorded in the EMR between the ages of 3 and 18. The generation of the cohort is shown in Figure 1.

All vital measurements recorded as part of eligible encounters were extracted for the study. Visits with BP measurements were identified and the patient's age at the time of visit was calculated. If more than one BP record was available for a single date, we calculated the mean systolic and diastolic BPs for that visit. If height was not recorded for an encounter with recorded BP, we used the closest height for the same age from other visits, if done within twelve months of the encounter. In order to determine whether a diagnosis of hypertension or a family history of hypertension were entered in the record, we searched each patient's summative health profile and encounter diagnosis records. The summative health profile (also called cumulative patient profile) is a standard area of the primary care chart, and contains summary data on chronic conditions, medications, allergies, immunizations, social history and family history.[11]

Each provider participating in CPCSSN completed a survey on their demographic and practice characteristics. We used data from the survey to describe providers.

Statistical Analysis

We used descriptive statistics to characterize the sample. We calculated the proportion of enrolled patients with at least two encounters from age 3 to 18 with at least 6 months between the first and last visit that had at least one BP measurement.

For each visit with an available weight and height, we calculated sex and age-adjusted BMI centiles using the most recent World Health Organization growth (WHO) charts.[12, 13] As recommended by the NHLBI,[4] we used the most recent Center for Disease Control and Prevention (CDC) growth charts [14] to calculate age, height and sex adjusted BP centiles for

each patient. We then derived the proportion of patients with abnormal BPs, using the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents' definitions.[3] For those with an initial abnormal BP, we ascertained the presence of a second BP measurement in the chart within six months.

The outcome for the patient level analysis was the count of the number of BP measures they had over their follow-up. Multivariate Poisson regression analysis was used to analyze variation in blood pressure measurement rates. Patients were nested within primary care providers; we therefore applied Generalized Estimating Equation (GEE) method to take into account the correlation between patients clustered within providers. The number of visits that a patient can have is influenced by their duration under care as a patient for a given physician. In this study, we calculated duration under care as the difference between the date of the first visit and the date of the last visit, or the date of data extraction (whichever came first) during the age range of interest. We used the logarithm of the duration under care as the offset in our Poisson regression models. We used regular Poisson regression to fit a model to each unique provider (i.e. we did not use a GEE model). Here the outcome was a count of the number of blood pressure measurements performed by each provider. The offset was the number of patient-years follow-up per provider. We adjusted for over-dispersion in these models by applying the Deviance scale correction factor to the estimated variance-covariance matrix of the regression coefficients. These two methods were used to model relationship between patient and provider characteristics with rate of BP measurement as outcome.

All tests were two tailed and a p-value of <0.05 was considered to be statistically significant. Data were analyzed using SAS version 9.3. The UTOPIAN - CPCSSN project has received ethics approval from the Research Ethics Board of the University of Toronto. All participating

CPCSSN sentinel primary care providers have provided written informed consent for the collection and analysis of their EMR data.

Results

There were 9,667 eligible patients; of these, 5,996 (62%) had at least one blood pressure recorded between the ages of 3 and 18 years. Patient characteristics for all patients and also for patients grouped based on BP recording rates are presented in Table 1.

Bivariate and multivariate associations between patient characteristics and rates of BP recording are presented in Table 2. Obesity or having a recorded family history of hypertension were not associated with an increased rate of BP recording.

Body mass index (BMI) was recorded more often when BPs were present in the EMR: 93.5% of children with a BP recorded also had a BMI recorded, while 48.3% of those with no BP record had a BMI in their chart (odds ratio 16.7, 95% CI 4.8-50, $p<0.0001$). 0.5% of patients had a recorded diagnosis of hypertension, and 3.2% had a recorded family history of hypertension in a first or second degree relative.

Physician characteristics associated with screening are presented in Table 3. Female physicians recorded BPs more often; no other significant association were found.

We were able to calculate BP centiles for 92% of patients with a BP recorded. 778 patients, or 8% of the total cohort (14% of patients with data allowing calculation of BP centiles) had at least one elevated BP. Forty (5%) of those patients had at least one further BP recorded within 6 months. We then limited the analysis to patients with at least one visit following the abnormal reading: 660 patients (85%) were seen at least once after, and 6.1% had a BP recorded within six

months. We further limited this to patients seen within six months after the abnormal reading: 317 patients (48%) were seen within six months and 13% had a BP recorded in any visit within the six month time frame.

Interpretation

In this study, almost two third of children and youth had at least one BP recorded as part of an office visit; 8% of the total cohort had at least one abnormal BP on record. However, once an abnormal BP was recorded, timely follow up was rare. Known risk factors such as obesity or a family history of hypertension were not associated with more frequent BP recording.

BP measurements were recorded in 71% of preventive visits in the US in 2008-2009.[15] Another U.S. study found that 8.4% of children and adolescents had at least one elevated BP during a four year period and 20.9% of elevated BPs were repeated within a month.[16] We found similar rates of abnormal BP recording, but much lower rates of follow up. Staff in the U.S. study had received training for paediatric BP measurement; we measured BP as routinely provided in community-based primary care with no supplemental training. As with other studies, difficulties in determining abnormal paediatric BPs may have led to errors in the recognition of elevated BP resulting in inconsistent follow up of abnormal readings.

In our study 0.5% of children and youth had a diagnosis of hypertension recorded in their summative health profiles or encounter records. The population prevalence of hypertension in children and adolescents is 1% to 5%,[2] indicating possible under-recognition of this condition. A U.S. study found poor recognition of hypertension: only 26% of children with multiple abnormal BP readings had a diagnosis of hypertension documented in their summative health

profile.[17] Under-diagnosis and under-management of hypertension in children and adolescents has been documented in multiple settings.[16-20]

Although male patients have higher rates of paediatric hypertension,[8] female patients were more likely to be screened, perhaps owing to contraceptive prescribing; measuring BP is recommended prior to starting the oral contraceptive pill.[21] Previous studies found that obesity and family history were the most significant predictors of a high BP reading in children,[15, 20] and obese children were more likely to be screened.[15] However, we found no statistically significant association between obesity or a record of a family history of hypertension and BP screening in our study.

The population prevalence of hypertension in Canadian adults is 23%.[22] In our study, only 3.2% of charts contained a record of a first or second degree relative with hypertension, indicating that family history for this condition is infrequently recorded for children.

We also examined provider related factors. Other than provider sex, factors including practice size or proportion of children in practice population were not associated with rate of screening for hypertension. In the U.S. there was no difference in screening between primary care paediatricians and family physicians.[15] Our sample included only family physicians and one nurse practitioner; the majority of primary care for children in Canada is provided in family practices.[23]

Limitations and strengths

The practices we studied represent a convenience sample of urban and sub-urban primary care providers rather than randomly selected practices. The sample only includes physicians using EMRs, who tend to be younger than their colleagues continuing to use paper records.[24]

However, the rates of recorded screening and follow-up were similar to studies conducted in the U.S., likely indicating an acceptable level for the external validity of this study. BMI was missing more frequently in children with no BP recorded. If obese children were more likely to have both BMI and BP recorded, those missing both BMI and BP may have lower BMI. Therefore, the finding of no association between BMI and BP screening in this study should be treated with caution. Our study has several strengths. It reflects care in community based primary care practices where children are usually seen for routine health services. We extracted data from several different EMR products, reflecting a variety of possible data entry processes in different applications. Finally, to our knowledge, this is the first Canadian study using EMR data to investigate paediatric hypertension screening rates and patterns of follow up .

Conclusions

Known risk factors such as obesity or family history of hypertension were not associated with more screening. Few abnormal readings were followed up in a timely manner and paediatric hypertension was likely under-recognized.

Clear recommendations regarding the selection of paediatric patients that would benefit from hypertension screening are needed. If BP is measured, processes such as automated flagging of abnormal results in EMRs and computerized clinical decision support should be implemented and studied as they may increase appropriate follow up of abnormal readings.

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Contributors: All authors contributed to conception and design. Babak Aliarzadeh was responsible for acquisition of data. Christopher Meaney, Babak Aliarzadeh, and Rahim Moineddin contributed substantially to the analysis of data. Patricia Parkin and Catherine Birken provided content-specific expertise on paediatric hypertension. Michelle Greiver, David White, and Babak Aliarzadeh provided expertise in the areas of primary care and use of EMR data. Babak Aliarzadeh and Michelle Greiver drafted the initial version of the article. All authors contributed to the interpretation of data. All authors reviewed and revised the article for important intellectual content and gave final approval of the version to be published.

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Table 1 - Patient characteristics according to rate of blood pressure recording

Number of patients (%)
Number of BP Measures: mean (SD) <numerator of rate>
Duration of Observation in years: mean (SD) <denominator of rate>
Number of Recorded Encounters Per Patient: mean (SD)
Mean age at first encounter in years (SD)
Age first BP recorded in years: mean (SD)
Female sex, N (%)
BMI, mean centile (SD) {Number of patients with data available}
obese, N (%)
recorded Family History of hypertension, N (%)

BP = blood pressure; SD = standard deviation; BMI = body mass index

Table 2 - Effect of number of encounters, sex, age, BMI, current diagnosis and family history of hyperte

Number of Recorded encounters	
Age at first encounter	
Female sex	
Mean BMI centile	
Obesity	
Recorded Family History of hypertension	

Note: Poisson regression used to model the rate of BP screening: number of recorded BP was used as outcome, a
Note: Intraclass correlation coefficient is approximately 0.36 - therefore Generalized Estimation Equation (GEE) wa
Note: Only variables with P-value<0.05 in bivariate model were included in multivariate model
BMI = body mass index; CI = confidence interval

Table 3 - Effect of care provider characteristics on rate of BP screening

Number of Visits Caring for Paediatric Patients	
Female sex	
Age (years)	
Years Since Graduation	
Practice Size*	
Proportion of Practice in 3-18 year age range	

Note: Poisson regression used to model the rate of BP screening; number of recorded BPs was used as outcome,
Note: Age and years since graduation were highly correlated; therefore only age was included multivariate model
Note: Only variables with p-value<0.05 in bivariate model were included in multivariate model
Note: Due to high correlation between age and years isnce graduation, we only included age in multivariate mode

*Practice size = number of enrolled patients in the practice
CI = confidence interval

All	No blood presssures recorded	BP recorded every four years or less often
9667	3671 (38.0)	681 (7.0)
1.37 (1.57)	0 (0)	1.01 (0.10)
3.25 (1.78)	2.82 (1.66)	5.33 (1.05)
7.88 (5.57)	7.03 (5.11)	10.43 (6.31)
9.26 (4.66)	8.39 (4.85)	8.01 (3.33)
10.97 (4.44)	NA	11.29 (3.73)
5098 (52.7)	1802 (49.1)	339 (49.8)
58.19 (29.16) {N=7380}	57.04 (29.17) {N=1773}	58.84 (29.81) {N=606}
875 (11.9)	181 (10.2)	83 (13.7)
312 (3.2)	67 (1.8)	12 (1.8)

ɪnsion on rate of BP screening

Bivariate		
Rate Ratio	**95% CI**	**P-value**
1.03	1.02, 1.04	<0.0001
1.06	1.03, 1.08	<0.0001
1.18	1.10, 1.28	<0.0001
1.11	0.91, 1.36	0.3
1.07	0.88, 1.31	0.5
1.44	1.02, 2.05	0.04

ıge period (duration) was used as offset

ɜs used to account for clustering of outcomes within physicians

Bivariate		
Rate Ratio	**95% CI**	**P-value**
0.99	0.99, 1.00	0.0429
1.35	1.04, 1.75	0.0233
0.98	0.97, 0.99	0.0159
0.99	0.98,1.00	0.0347
0.99	0.99, 0.99	0.0017
0.77	0.11, 5.15	0.7872

number of patient years follow-up per provider was used as offset; N=79 care providers

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BP recorded every 2 years to every 4 years	BP recorded every year to every two years	BP recorded more than once a year
1529 (15.8)	2387 (24.7)	1399 (14.5)
1.47 (0.62)	2.54 (1.36)	3.02 (1.89)
3.95 (1.48)	3.48 (1.75)	2.23 (1.52)
8.53 (5.58)	8.35 (5.64)	7.39 (5.64)
9.37 (4.15)	9.64 (4.45)	11.34 (4.78)
11.08 (4.22)	10.44 (4.48)	11.60 (4.81)
780 (51.0)	1315 (55.1)	862 (61.6)
60.21 (28.90) {N=1424}	57.66 (29.08) {N=2271}	58.16 (29.15) {N=1306}
198 (13.9)	255 (11.2)	158 (12.1)
41 (2.7)	123 (5.2)	69 (4.9)

Multivariate		
Rate Ratio	**95% CI**	**P-value**
1.03	1.02, 1.04	<0.0001
1.06	1.03, 1.10	0.0002
1.12	1.03, 1.20	0.01
-	-	-
-	-	-
1.26	0.81, 1.95	0.3

Multivariate		
Rate Ratio	**95% CI**	**P-value**
1.00	1.00, 1.00	0.2
1.41	1.04, 1.89	0.02
0.98	0.97, 1.00	0.09
-	-	-
1.00	1.00, 1.00	1
-	-	-

	All cohort (females)	OCP users	Non OCP users	All cohort (males)
All	6085	665	5420	5294
screened	3941	546	3395	3151
	65%	82%	63%	60%

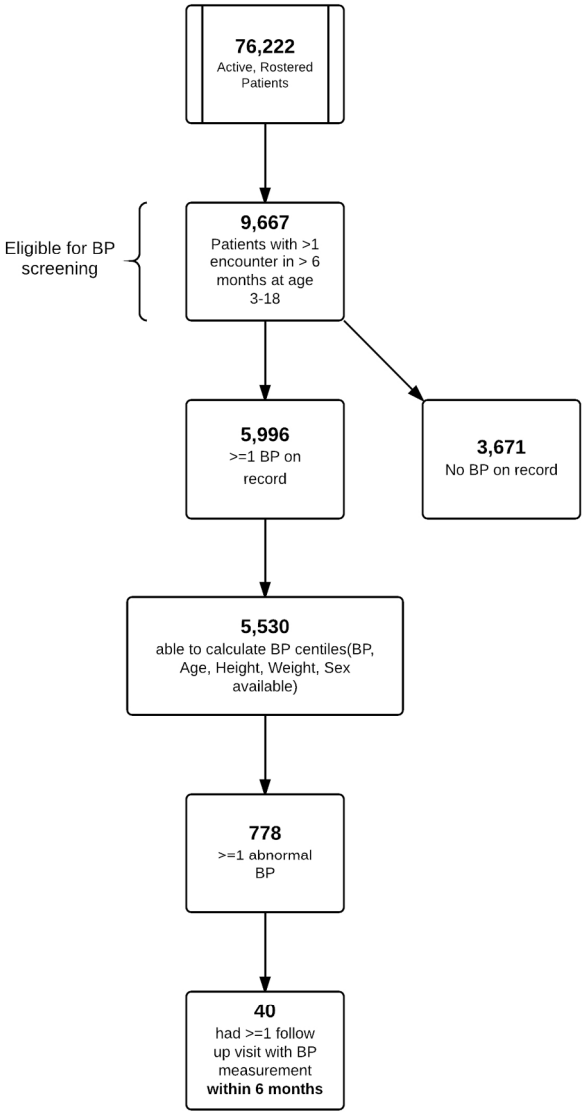
76,222
Active, Rostered Patients
Eligible for BP screening
9,667
Patients with >1 encounter in > 6 months at age 3-18
5,996
>=1 BP on record
3,671
No BP on record
5,530
able to calculate BP centiles(BP, Age, Height, Weight, Sex available)
778
>=1 abnormal BP
40
had >=1 follow up visit with BP measurement
within 6 months

Figure 1