



DAVIES
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***Recognizing Pediatric
Elevated Blood Pressure***
using an EPIC Best Practice Alert

Recognizing Pediatric Elevated Blood Pressure using an EPIC Best Practice

Executive Summary

Atherosclerotic cardiovascular diseases (ASCVD) such as heart attack and stroke have their roots beginning in childhood and adolescence with the inception of risk factors such as high blood pressure (hiBP). Unfortunately, data from others (Hansen et al, 2007) and your authors (Twichell et al, 2017) show hiBP is grossly under-recognized in youth, leading to the American Academy of Pediatrics (AAP) to reformulate the abnormal thresholds in September 2017 (Flynn et al, 2017).

Texas Children's Pediatrics (TCP), the largest primary care pediatric group practice in the USA, formulated a multipart intervention to improve hiBP recognition in January 2019, one part of which was an electronic health record-based EPIC pop-up best practice alert for medical assistants and, separately, medical providers, highlighting a measured hiBP and then suggested further actions that indirectly signal provider recognition of hiBP as the key outcome of interest defined as ICD10 diagnosis, hiBP on the problem list, referral to specialist provider, or hiBP medication.

Data was compiled on all adolescents visiting TCP practices 14 months pre- intervention (n=7,444) and 14 months post-intervention (n=4,546) on these hiBP recognition indicators. This data analysis showed a 66% relative increase in hiBP recognition indicators (pre 15% vs post 25.4%, $p < 0.0001$). Medication treatment specifically relatively increased by 67% (1.9% vs 3.1%, $p = 0.001$). Temporal trends showed complex patterns. Therefore, the TCP hiBP intervention was associated with higher proportions of recognition and treatment, but acceptable levels are not yet being achieved.

The Clinical Problem and Pre-intervention Performance

Cardiovascular disease (CVD) risk factors are now highly prevalent among children. Roughly 20% have abnormal cholesterol and 14% have hiBP (9, 22). Focusing on BP, hiBP in youth is associated with seizures and cognitive abnormalities in childhood and predicts future adult CVD events and mortality (4, 24, 25). A moderate proportion of pediatric hiBP tracks into adulthood (26-28). Longstanding guidelines recommended frequent screening for hiBP. But despite this importance, studies repeatedly show that provider recognition of hiBP in pediatric primary care practice is inadequate, ranging from 10-25%. There may be several reasons for this care gap including: difficult-to-parse age-sex-height referenced normative values, challenges in proper measurement technique, lack of proper equipment to measure blood pressure, lack of knowledge or interest in hiBP management, and the necessity to follow BP measurements across time since three separate episodes are required for a hypertension diagnosis, which in turn is predicated on provider signaling recognition.

In September 2017, the AAP promulgated a clinical practice guideline in which hiBP screening was recommended frequently, but at a minimum yearly, with properly sized cuffs, using proper techniques, and encouraged but not required electronic health record (EHR)-based solutions to support clinical provider recognition of hiBP. Critically, the abnormal threshold for youth 13 and older was simplified to systolic at or above 130mmHg and diastolic at or above 80mmHg. Multiple episodes of hiBP are required to diagnose true hypertension, making hiBP recognition, signaling and tracking across visits crucial for initiating management.

Indicators of hiBP recognition signaling are defined by the AAP and previous literature as the key quality measure. HiBP recognition is defined as ICD-10 diagnosis, hiBP on the EHR problem list, referral to hiBP specialties nephrology

or cardiology, and/or the initiation of hiBP pharmacotherapy, treated collectively as the primary numerator of interest, or each of the four components individually treated as secondary numerators. Investigations were not included as indicators as CPG deemphasized testing. The denominator of interest is hiBP recorded in the EPIC EHR defined as at or above 130/80. These outcome proportions were examined in patients 13-19 years old of all sexes and genders, all races and ethnicities visiting TCP primary practices for whom this threshold is applicable. There were no exclusion criteria. Data was extracted from EPIC. From October 2017 to November 2018, the average monthly proportion with any recognition was 15.0%, specifically with ICD-10 diagnosis in 10.1%, hiBP on the problem list 5.6%, specialty referral 5.2%, and medication therapy in 1.9% with patients possibly being in more than one category. Improvement was targeted from these very low levels.

Design, Implementation Model Practices and Governance

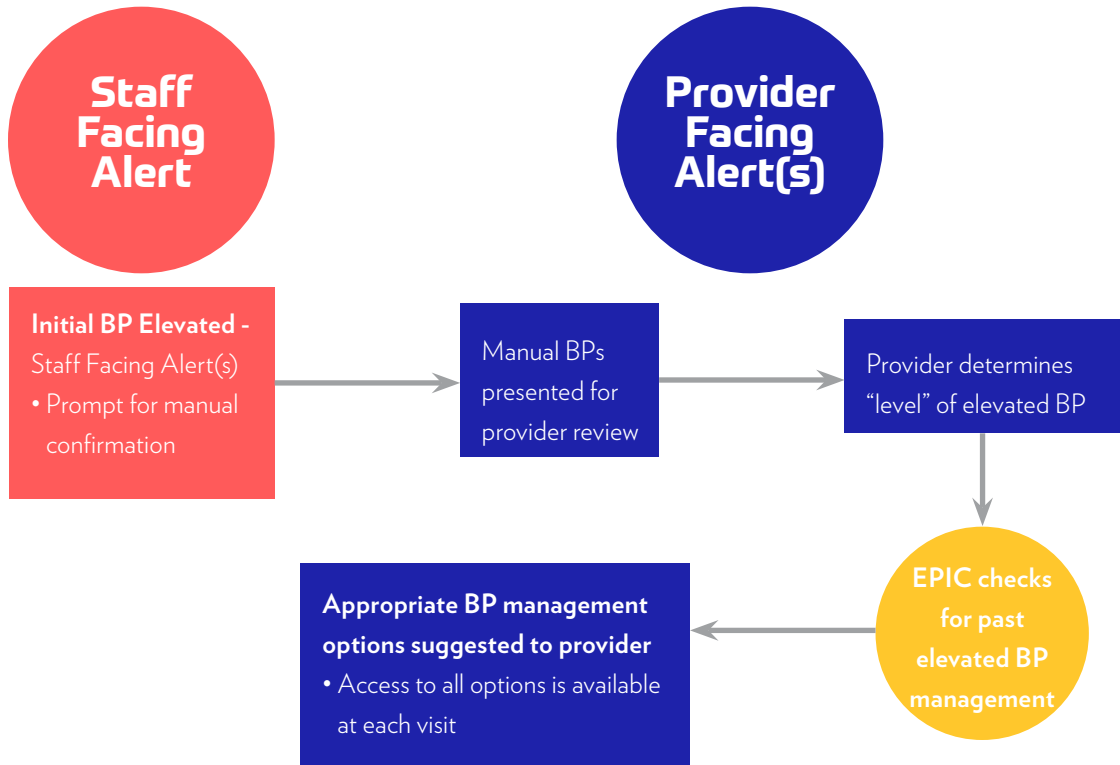
TCP identified hiBP recognition as a priority for optimal care. This grass-roots decision was then endorsed and supported by the chief medical officer of TCP to mobilize material resource procurement and technological support expertise. Key instruction leaders from clinical provider and medical assistant personnel cadres were selected and met with multidisciplinary project teams to develop and verify the retraining program adhered to 2017 CPG guidelines. Finally, the team introduced a bespoke best practice alert (BPA) for clinical decision support to highlight hiBP to medical assistants and nurses (staff), and separately to clinical providers with management recommendations.

The intervention was multi-level. First, the full array of blood pressure cuff sizes and related equipment were purchased and deployed in each of the more than 50 multi-provider practices. Second, a retraining program was implemented for staff and providers on proper BP measurement technique based on AAP 2017 CPG, including EHR embedded diagrams for proper technique. Third was the clinical decision support tool BPA. Briefly, hiBP on automated oscillometric methods entered in EPIC by staff triggers the staff BPA to repeat and inform the provider. When the provider enters the patient chart, the provider BPA supports further management predicated on the number of previous hiBP episodes and height of hiBP. Based on 2017 CPG guidelines for ICD-10 diagnoses and problem list entries, referral to specialists, laboratory measures and therapies such as lifestyle management and pharmacotherapy are included.

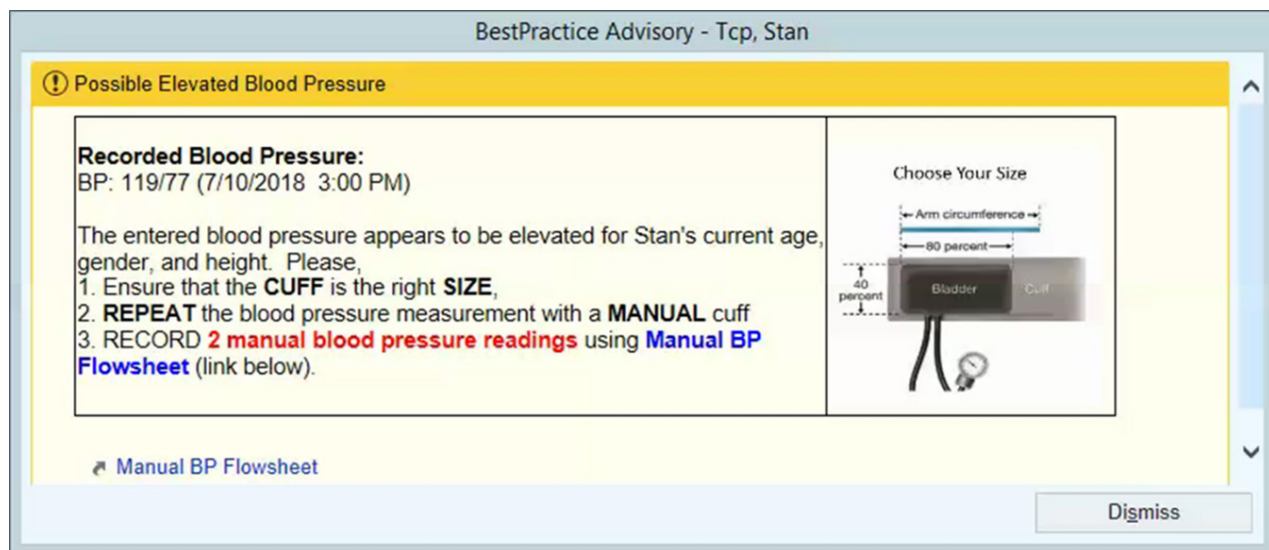
The intervention design process, training and implementation was coordinated between TCP's informatics champion and preventive cardiology champion with support from TCP's Quality Team, nursing and medical assistant leadership to assist in training for appropriate BP measurement techniques. Implementation decisions and majority of intervention testing, especially BPA, were made primarily by the TCP physician informaticist with oversight by the CMO and TCP operations team directors. Several iterations were developed in identifying a single workflow applicable to the more than 50 multi-provider practice sites comprising TCP, the largest primary care pediatric group practice in the U.S. After development, a live webinar was delivered and archived for clinical providers and medical assistants to roll-out the BPA and reinforce stand-of-care AAP 2017 CPG. Uptake was enhanced by the extensive familiarity of TCP providers and staff with previous BPAs for unrelated conditions and the trainings were completed within roughly three months for staff and providers.

Clinical Transformation Enabled Through Information and Technology

The technology enhanced workflow begins when a hiBP is entered into EPIC for an ≥13-year-old:




When a hiBP is entered in EPIC by staff, the following pop-up display deploys:



While dismissal is possible at each stage, this alert intends to highlight the BP, reiterate proper technique with an infographic and encourage standard-of-care in recording of auscultatory manual BP measurements.

Then, the measured manual BPs are presented in a separate provider BPA for review, as below. Using the acknowledgement buttons at the bottom of this BPA, the provider can designate a BP category.

⚠ Possible Elevated Blood Pressure



Drum's initial blood pressure this visit appeared to be elevated.
BP: 121/75 (12/12/2018 3:11 PM)

Manual confirmation showed:
Initial Manual BP: 119/81 **Repeat Manual BP: 123/80**

Blood pressure targets for adolescents: Elevated BP: 120/80, Stage 1 HTN: 130/80, Stage 2 HTN: 140/90.

1. Use the [Manual BP Flowsheet](#) to enter any additional blood pressure readings performed.
2. **Review** the manual BP readings above
3. Use the **buttons below** to provide your **interpretation** of this visit's **average manual blood pressure** for Drum.

Enact
Ignore
Add goal: settle bp eating plan [lifestyle]

[Manual BP Flowsheet](#) ↗

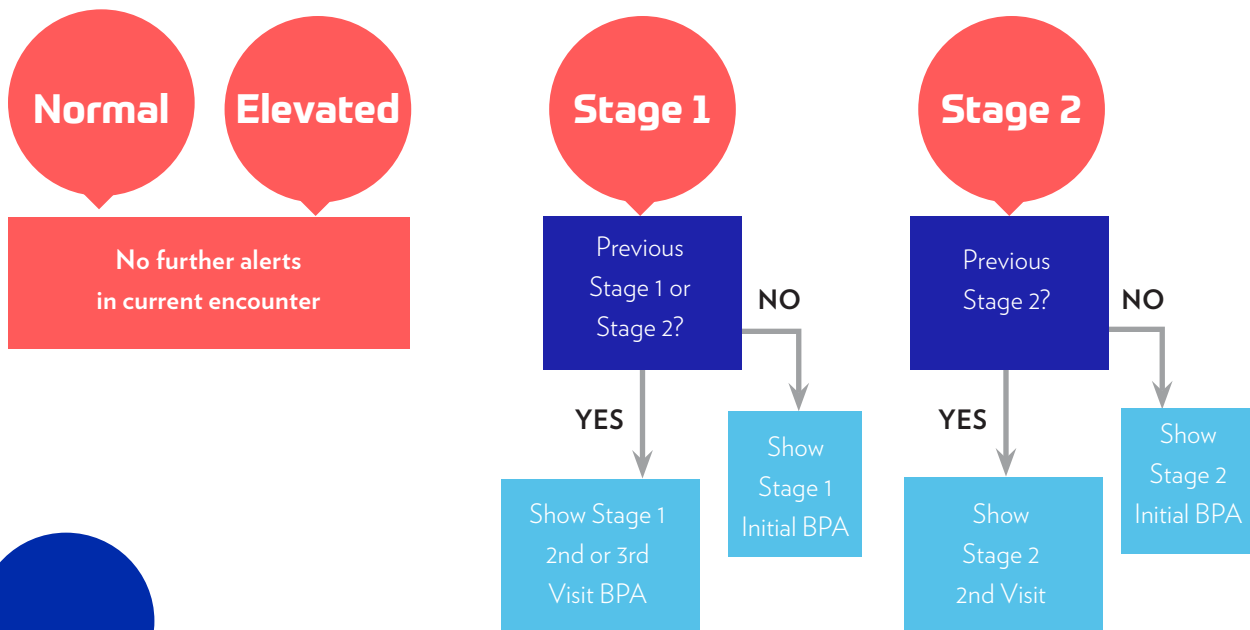
Acknowledge Reason _____

Normal (<90%)
Elevated (90-95%)
Stage 1 (95%-95%+12mmHg)
Stage 2 (>95%+12mmHg)

✓ Apply Selected

Subsequent support depends on degree of elevation and initial versus repeated episode as follows:


Provider Interpretation



Initial Management Provider BPA supports vigilance at three visits for BP measurement, lifestyle management (or immediate medication as guideline-directed), and recognition signaling, e.g. problem list:

High Blood Pressure - Initial Management

Blood Pressure Today's average manual blood pressure was evaluated as **Stage 1.**



From available past data, this is Drum's **FIRST** Stage 1 BP reading.

Please review past BP data (table below).
Additional readings can be recorded in [Manual BP Flowsheet](#) (link below).

Use the **Initial Management of Pediatric Hypertension SmartSet** to follow the AAP 2017 Guidelines for Stage 1 HTN:

1. Consider nutrition or weight management referral (if appropriate)
2. **Recheck** within **2 weeks** and **3 months**
3. If BP remains over Stage 1 HTN level at the 3rd visit; initiate evaluation, referral, and treatment.

MANAGEMENT

Goal for Hypertension Diet not active

<input checked="" type="checkbox"/> Open SmartSet	<input type="checkbox"/> Do Not Open	Initial Management of Pediatric Hypertension <small>preview</small>
<input checked="" type="checkbox"/> Add Problem	<input type="checkbox"/> Do Not Add	Elevated BP without diagnosis of hypertension > Edit details
<input type="checkbox"/> Enact	<input checked="" type="checkbox"/> Ignore	Add goal: settle bp eating plan [lifestyle]

[Manual BP Flowsheet](#) ↗

Apply Selected

An example of Initial Visit Smartset is as follows:

SMARTSET

Stage 1 HTN

▼ Stage 1 Management Panels

- Stage 1 - Initial Management
 - Elevated BP without diagnosis of hypertension [R03.0] [Details](#)
 - Upper and Lower Extremity BP Check
 - Blood Pressure Recheck - 2 weeks [Details](#)
 - Blood Pressure Recheck - 3 months [Details](#)
- Stage 1 - 2nd Visit Management
- Stage 1 - 3rd Visit Management

Stage 2 HTN

▼ Stage 2 Management Panels

- Stage 2 - Initial Management
- Stage 2 - 2nd Visit Management

Ad-hoc Orders (Type to search)

You can search for an order by typing in the header of this section.

SmartSet in Stage 1 second visit:

Stage 1 HTN

▼ Stage 1 Management Panels

- Stage 1 - Initial Management
- Stage 1 - 2nd Visit Management
 - Elevated BP without diagnosis of hypertension [R03.0] [Details](#)
 - Upper and Lower Extremity BP Check
 - Routine, Clinic Performed
 - Blood Pressure Recheck - 3 months [Details](#)
- Stage 1 - 3rd Visit Management

At a third visit with hiBP, the BPA encourages investigation and other guideline-directed actions through BPA, Smartset and Order Set with CPG recommended orders toggled on as default:

Use the **Initial Management of Pediatric Hypertension** SmartSet to follow the AAP 2017 Guidelines for Stage 1 HTN:

1. Initiate lab evaluation and referral to Cardiology or Renal.
2. **Recheck within 3 months**
3. Check **Upper and Lower Extremity BP** (if not already performed)

Subsequent hiBP Stage 1 Visit BPA (Stage 2 differs slightly):

Stage 1 HTN

▼ Stage 1 Management Panels

- Stage 1 - Initial Management
- Stage 1 - 2nd Visit Management
- Stage 1 - 3rd Visit Management

Evaluation of Persistent Stage 1 BP elevation (3 or more visits)

If not previously obtained, **Upper and Lower Extremity BP** check is recommended.

Pre-checked orders are for standard work up. Patient specific factors or family history may warrant additional evaluation, such as:

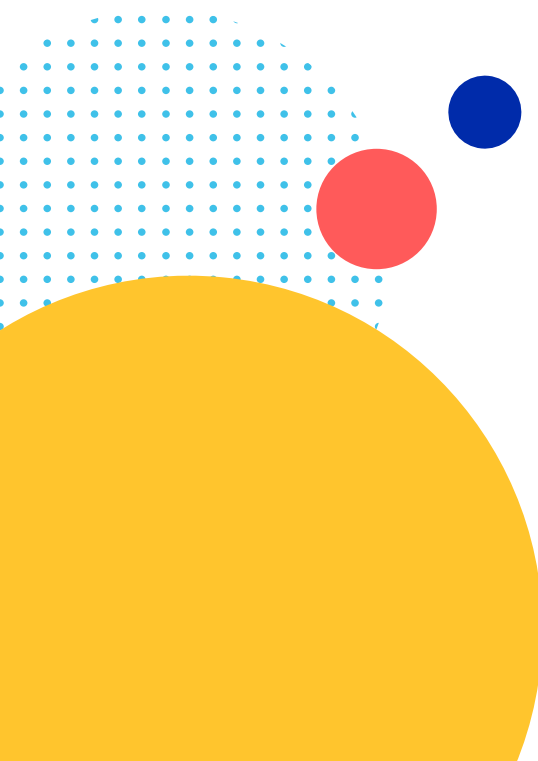
- **BMI > 95%:** Add HgbA1c, ALT, and GGT
- **Possible Sleep Apnea:** Add Sleep Study
- Atypical weight gain/loss, agitation, jitteriness, etc.: Add TSH/T4 or urine drug screen, if appropriate

Provided image is cut off. Please send a replacement.

Use the **Initial Management of Pediatric Hypertension** SmartSet to follow the AAP 2017 Guidelines for Stage 1 HTN:

1. Consider nutrition or weight management referral (if appropriate)
2. **Recheck within 3 months**
3. Check **Upper and Lower Extremity BP**
4. If BP remains over Stage 1 HTN level at the 3rd visit, initiate evaluation, referral, and treatment.

- Elevated BP without diagnosis of hypertension [R03.0] [Details](#)
- Pediatric Hypertension (Stage 1) [I10] [Details](#)
- Upper and Lower Extremity BP Check
- Basic Metabolic Pnl
 - Lab Collect, Routine
- CBC With Plat And Diff
 - Lab Collect, Routine, Blood
- Lipid Panel with Reflex to Direct LDL
 - Lab Collect, Routine, Blood
- Hemoglobin A1c [BMI >= 95%]
- ALT [BMI >= 95%]
- GGT [BMI >= 95%]
- T4 Free
- TSH (Quest)
- TSH (TCH/External)
- Sleep Study/Sleep Clinic
- URINALYSIS WO MICRO AUTO (POCT)
 - Routine
- URINALYSIS WO MICRO POC
- Drug Screen, Clinical-1, Urine
- ECG Request
 - Routine, Expires-12/12/2019
 - Reason for exam? Other-Please Comment
 - Page Requesting Physician? (enter pager number in comment field): No
- Echocardiogram without Sedation
 - Routine, Expires-12/12/2019
 - Current Diagnosis? Elevated BP
 - Reason for exam? Elevated BP
 - Page Requesting Physician? (enter pager number in comment field): No
 - IV contrast (Optison 3 mL diluted in 7 mL NS, maximum dose 8 mL) may be given to adequately evaluate ventricular function. No
- Referral to Cardiology
 - Routine, Internal Referral, Cardiology, Specialty Services Required
 - Reason for Consultation: Prevention Clinic
- Referral to Renal
- Blood Pressure Recheck - 3 months [Details](#)



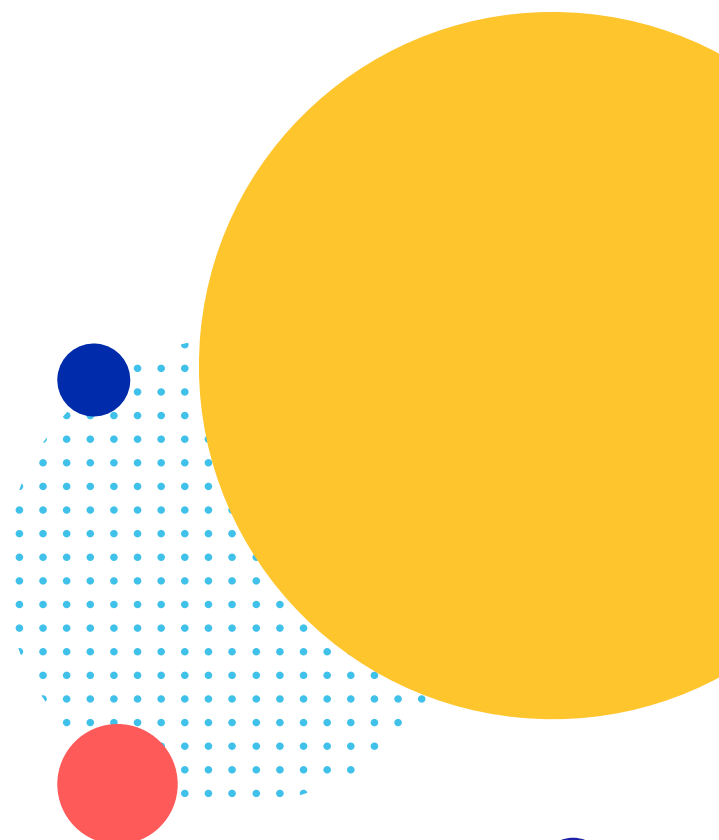
Improving Adherence to the Standard of Care

TCP targeted improvement from previous very low levels in the context of AAP 2017 CPG, encouraging full recognition signaling of all hiBP. HiBP recognition is defined as ICD-10 diagnosis, hiBP on the EHR problem list, referral to hiBP specialties nephrology or cardiology, and/or the initiation of hiBP pharmacotherapy, treated collectively as the primary numerator of interest, or each of the four components individually treated as secondary numerators. Investigations were not included compared to previous publications, because the 2017 CPG deemphasized testing in probable essential hypertension. The denominator of interest is hiBP recorded in the EPIC EHR, defined as at or above 130/80. These outcome proportions were examined in patients 13-19 years old of all sexes and genders, all races and ethnicities visiting TCP primary practices for whom this threshold is applicable. The exclusion criterion for the post intervention period was previous recognition, i.e. evidence of hiBP recognition in the pre-intervention period. Data on the indicator numerators and denominator were extracted from EPIC provider entered data.

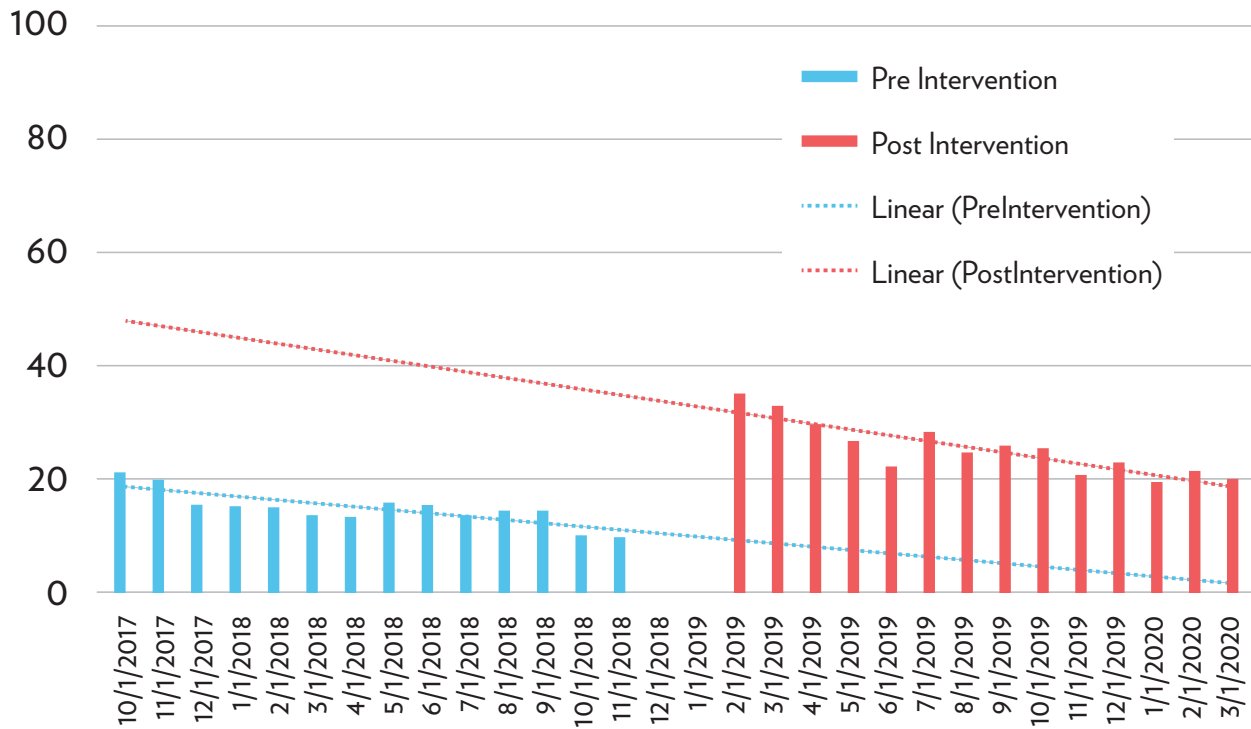
In the post-intervention period from February 2019 to March 2020, the proportion of hiBP with any recognition increased relatively by 66% (25.4%), ICD-10 diagnosis by a relative 100% (20.1%) and problem list by 137% (13.1%) [Table 1].

The chart shows monthly data of 1) AnyRecognition as a proportion of hiBP in pre-intervention period with 95% control limit (CI) (blue) and post-intervention (orange), including color-matched trendlines and goal recognition noted at 100%. A clear “level change” in the trendlines is seen post versus pre-intervention, but a declining slope is still seen after the intervention very similar to pre-intervention pattern. The ideal 100% recognition is not met, in context of a “Dismiss” option in the BPA.

TABLE 1 Outcome	Post- vs Pre- Intervention difference in average monthly proportion (95% Confidence Interval)	P value
Any Recognition/ hiBP	+10.4%(8.7,12.0)	4.6x10 ⁻⁹
ICD10/hiBP	+10.0%(8.2, 11.8)	1.9x10 ⁻⁸
Problem List/hiBP	+2.3%(1.0, 3.6)	1.2x10 ⁻⁶
Specialty Referral/ hiBP	+1.2%(0.6, 1.9)	0.002
Medication/ hiBP	+7.6%(5.7, 9.5)	0.001



Any Recognition/hiBP

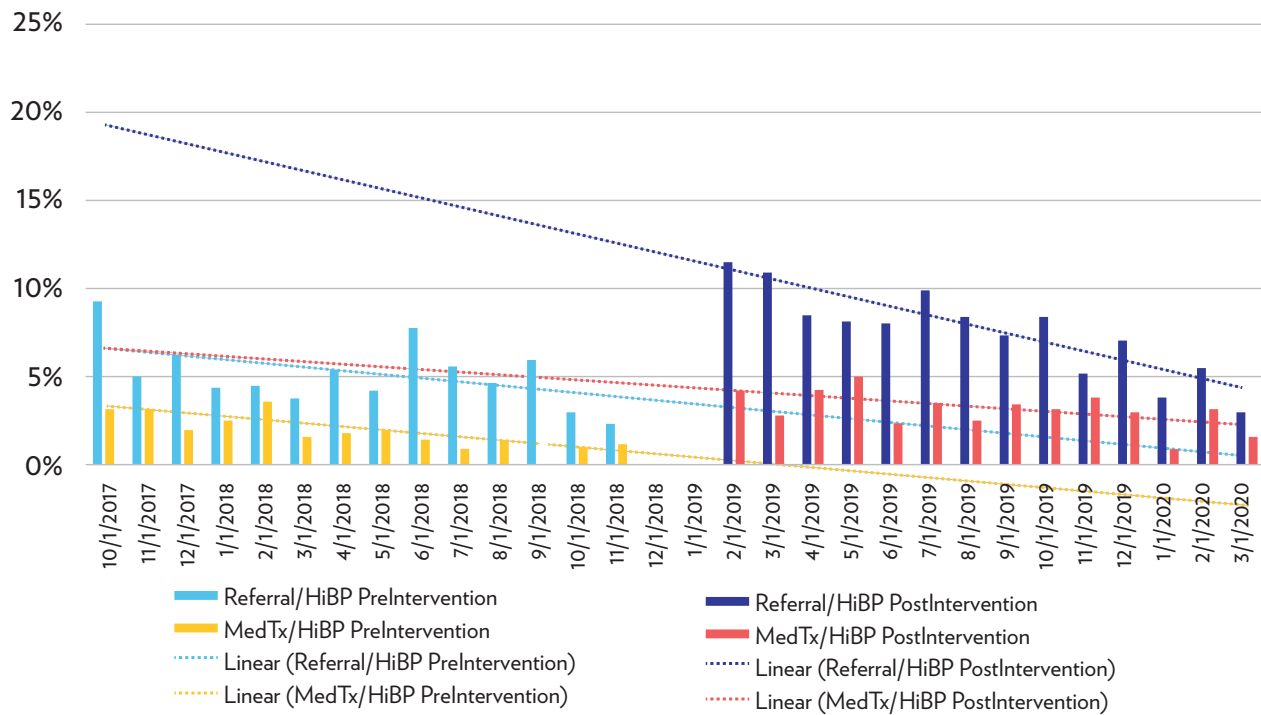


Improving Patient Outcomes

Pediatric hiBP recognition should trigger further management. Beyond signaling recognition, management actions could include referral to specialists for further attention or lifestyle management initiation from providers in nephrology, cardiology and medication therapy. Previously, investigations had also been included but the AAP 2017 CPG deemphasized investigations in patients with probable essential hypertension coupled with alternate co-existing triggers for investigations, such as obesity, lipid disorders or fatty liver. For these management outcomes, specialty referral relatively increased by 44% (7.5%), and medication therapy relatively increased by 67% (3.1%) [Table 1].

The below chart shows clinical actions including specialty referral pre- (light blue) vs post-intervention (dark blue) including 95% errors with color-matched trendlines and BP medication pre- (light green) vs post-intervention (dark green) and trendlines. There are not widely accepted goals on the desired proportion of these outcomes given that many youths will improve with PCP management and do not need specialty referral.

Clinical Outcomes: Specialty Referral OR Medication treatment



Accountability and Driving Resilient Care Redesign

Real time aggregate performance metrics were not made available to providers for their personal practice nor group practice. Post implementation no substantive modifications were made to the intervention. However, at inception of this project aggregate performance measures of recognition and clinical outcomes within practices and comparing practices as well as sociodemographic disparity analyses were envisioned and are currently ongoing. Furthermore, the non-seasonal declining patterns over time and gap vs. desired recognition goal offer ample grounds for ongoing analyses to design methods to improve, including planned interrogation of providers for long-term usability, workarounds and modified patient care flows.

References

1. Hansen, M. L., Gunn, P. W., & Kaelber, D. C. (2007). Underdiagnosis of hypertension in children and adolescents. *JAMA*, 298(8), 874–879.
2. Twichell, S. A., Rea, C. J., Melvin, P., Capraro, A. J., Mandel, J. C., Ferguson, M. A., Nigrin, D. J., Mandl, K. D., Graham, D., & Zachariah, J. P. (2017). The effect of an electronic health record-based tool on abnormal pediatric blood pressure recognition. *Congenital heart disease*, 12(4), 484–490.
3. Flynn, J. T., Kaelber, D. C., Baker-Smith, C. M., Blowey, D., Carroll, A. E., Daniels, S. R., de Ferranti, S. D., ... Urbina, E. M., & SUBCOMMITTEE ON SCREENING AND MANAGEMENT OF HIGH BLOOD PRESSURE IN CHILDREN (2017). Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. *Pediatrics*, 140(3), e20171904.

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