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How Smart is Technology?: Understanding the Role of Clinical Decision Support in the Primary Care Setting

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Clinical decision support systems (CDSS) are tools developed for clinicians to aid in complex decision making and to improve healthcare outcomes. A traditional - CDSS is a software that is designed to extract relevant patient data, match that data to a clinical knowledge base, and analyze this information to present the provider with an assessment or recommendation. Usually, this software is either programmed to work within or in conjunction with an electronic health record (EHR) or computerized provider order entry (CPOE) system already in use at the healthcare institution.[1] Simple CDSS are already integrated into most EHR systems to prompt clinicians to deliver evidence-based care, discourage non-indicated care, optimize drug orders, and improve documentation. In general, most interventions currently made by CDSS focus on improving safety and preventing errors. For example, Epic, an EHR highly utilized across many health systems, will notify a provider when a drug is ordered at a dose inappropriate for patient weight. However, more complex CDSS that aim to optimize patient care beyond mere safety interventions have yet to be widely implemented.[2]

A field that could potentially benefit greatly from the implementation of more complex CDSS is within primary care. Primary care often consists of treating chronic disease states with a focus on preventative care measures. Decision-making in these areas could be greatly optimized through an increased utilization of advanced CDSS, yet most clinics have been hesitant to implement them into workflow despite the recent developments of such systems. This is likely due to research limitations, where difficulties incorporating an entirely new and unfamiliar technology into a pre-existing healthcare system makes it difficult to generate high-quality evidence that can show population-level improvements in healthcare outcomes.[3]

The purpose of this review is to explore the potential future uses of CDSS in the primary care setting. This is done by discussing the results of a couple recent studies while also confronting barriers that must be addressed before widespread implementation is possible. Of the two clinical trials reviewed, one researched the effect of a CDSS called "CV Wizard" on the reduction of reversible cardiovascular risk[4] while the other aimed to improve the identification and diagnosis of pediatric hypertension through a CDSS called "TeenBP."[5]

Clinical Trials

CV Wizard: Cardiovascular Disease Risk Reduction[4]

The potential role of Clinical Decision Support in risk reduction for patients has been demonstrated in a recent clinical trial published by Rachel Gold, et al. in the Journal of the American Medical Association (JAMA) in February 2022.[4] The objective of this study was to evaluate the impact of a CDSS tool in reducing the risk of cardiovascular disease (CVD) in community health centers. This trial included 70 community health center clinics in the United States which were randomized into a control (28 clinics) and intervention group (42 clinics.) The primary endpoint of the trial looked to assess the one-year change in total ASCVD risk and reversible CVD risk. The reduction in reversible CVD risk was considered "achieved" if six key risk factors reached evidence-based levels of control and included: cholesterol levels, blood pressure, diabetes control, weight, smoking status, and use of aspirin.

Trial protocol utilized a new clinical decision support tool named "CV Wizard" which was integrated into the clinics EHRs of the intervention arm and used available patient data to identify eligible patients. Inclusion criteria included those aged 40-75 years old, diagnosed with diabetes or atherosclerotic CVD, and had at least one uncontrolled risk factor that could be addressed to reduce overall ASCVD risk. Of the patients available for enrollment, 18,578 patients were automatically enrolled in the study based on inclusion criteria and CV Wizard calculated their 10-year ASCVD risk using standardized calculations and analyzed data within the EHR. Once patient ASCVD risk was calculated, the CDSS generated personalized risk-reduction recommendations. These recommendations were only visible to providers in the intervention clinics, while the control clinics had CV Wizard running in the background to collect data for later comparison.

Clinic workflow was minimally impacted by CV Wizard and was integrated by presenting rooming staff with a pop-up link on the EHR interface whenever an eligible patient was being roomed. The interface displayed two patient-specific reports: one meant

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for the physician and one for the patient, with the option to print desired report. The clinician report provided a quick overview of the patient's calculated ASCVD risk level and suggested interventions prioritized by level of evidence for greatest impact on ASCVD risk reduction. Commonly, these recommendations addressed the six reversible risk factors. For example, one intervention involved the initiation of an appropriately dosed statin, while another intervention involved a conversation discussing smoking cessation. The patient-friendly version of the report (**Figure 1**) was intended to function as supplemental material to help facilitate understanding during the shared-decision making process of addressing the identified risk factors. Unfortunately, the study did not collect data on whether the provider and/or patient-friendly reports were utilized during the patient encounter.

For purposes of the study, use of the CV Wizard was determined only by the generated reports that were accessed by rooming staff. Results showed that the reports were accessed in 34.7% of index encounters and 19.8% of all eligible encounters (which includes all follow-up visits within the study timeframe where eligibility criteria were still met). With this limitation in mind, the true rate of utilization of this tool by the provider and patient could be significantly less than reported.

Ultimately, when using an intention-to-treat (ITT) analysis, neither total ASCVD nor reversible CVD risk improved significantly in patients within the intervention clinics than the control clinics. However, the effect of treatment on the treated (ETOT) analysis revealed that total ASCVD risk decreased significantly (an absolute decrease of 4.4% in the intervention group v. 2.7% in the control group) when the tool was accessed at least once. The conflicting results between the ITT and ETOT analyses can most likely be attributed to the low use rates of CV Wizard overall. This led to an inability to detect a population-level benefit, with benefits only observed when analyzing data of the subgroup selected.

Authors conclude this study demonstrates the potential benefit of CDSS in primary care along with limitations for its use. While it is unclear why the use rates were so low, the results signify that a population-level benefit of CDSS cannot be detected without appropriate and consistent use of the CDSS. On the other hand, a clear benefit of decreased ASCVD risk was observed in the group of patients where the tool was used. This suggests that CV Wizard will be effective at reducing ASCVD risk on a population level if use rates are high, but effects will be limited when use rates are low.

TeenBP: Identifying Pediatric Hypertension[5]

In 2018, a randomized clinical trial published in the American Academy of Pediatrics was conducted in the pediatric population to assess the utility of CDSS in diagnosing pediatric hypertension.[5] Although blood pressure is measured routinely at pediatric visits, hypertension is often overlooked in children and adolescents despite evidence suggesting that it affects ~3.5% of the population.[6] Unlike in adults, blood pressure in children and adolescents is classified based on the normative distribution in healthy children, with hypertension defined as a systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) ≥ 95th percentile for age group. Patient biological sex, age, and height must all be considered to determine patient percentile. As a result, blood pressure tables (**Table 1**) have been created and incorporated into guideline treatment by the American Academy of Pediatrics (AAP) taking these factors into consideration.[6]

Concern for continued low diagnosis rates of hypertension in the pediatric population may be due to the perceived complexity of the blood pressure tables and/or the overall low suspicion of hypertension in pediatrics. However, multiple systematic reviews have found that elevated blood pressure in childhood increases the risk for adult hypertension and metabolic syndrome. In addition, secondary causes of hypertension are more common in this population than in adults, so proper detection and treatment is vital to reduce the risk of future health complications.

To address the underdiagnosis of hypertension in pediatric patients, Kharbanda, E et al. developed a CDSS tool named "TeenBP" to assist providers during patient encounters. This tool communicated with healthcare providers through the use of up to three best practice alerts (BPAs) per encounter. Each BPA triggered based on available information within the EHR and pertained to hypertension guideline recommendations. The first possible BPA alerted for a height measurement if one had not been documented within the past 12 months. The second requested a

Figure 1 | CV Wizard Patient-Friendly Printable Report[4]

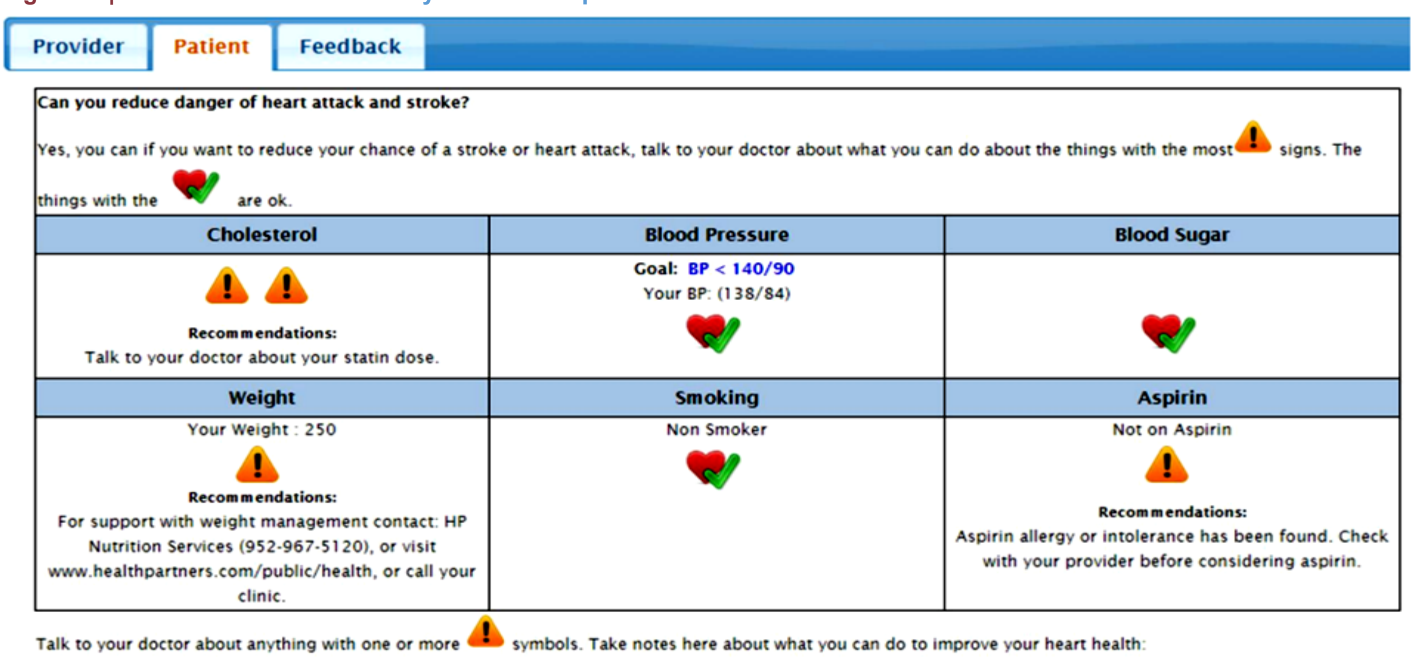


Table 1 | American Academy of Pediatrics Blood Pressure Table for One-Year-Old Boy[6]

Age (y)	BP Percentile	SBP (mm Hg)							DBP (mm Hg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	30.4	30.8	31.6	32.4	33.3	34.1	34.6
	Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9	77.2	78.3	80.2	82.4	84.6	86.7	87.9
	50th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
	90th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
	95th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
	95th + 12 mm Hg	114	114	115	115	116	117	117	66	66	67	67	68	69	69

second blood pressure measurement if the first blood pressure reading was ≥ 95th percentile. If two measurements were obtained, the third BPA fired to notify the rooming staff that either the average of the measurements was within normal limits (meaning that no further action was needed), or that the average was above normal limits and the provider should be notified.

If it was determined that the provider should be notified, the provider received a single BPA alert upon opening the patient chart stating, "the patient meets criteria for hypertension." This alert included a link to review the blood pressure history and a suggested plan for the patient (**Figure 2**). The plan provided by the CDSS included recommendations for a diagnosis of hypertension, lipid screening (if not recorded in the previous year), and a nutrition referral. A workup for secondary hypertension was recommended for patients with blood pressures ≥ 99th percentile or a BMI < 85th percentile. Ultimately, clinical decision-making was determined by the practitioner with input from CDSS.

In this study, a total of 20 primary care clinics were randomly assigned into a control or intervention group. Both groups consisted of 10 clinics. The intervention group included TeenBP programming into the EHR while the control group did not. A one-hour training session on appropriate use of the software was offered to the staff in the intervention clinics. A total of 31,579 patients between the ages of 10-17 visited both clinics during the study time frame. Researchers performed an automated review (via TeenBP) of diagnoses along with a manual review of clinical notes, prescriptions, and diagnostic testing in order to identify those with diagnosed hypertension. This review identified that a total of 1.7% of the study population met diagnostic criteria for hypertension. In the intervention clinics, 54.9% of these patients were accurately diagnosed within six months, while 21.3% of patients were diagnosed in the usual care clinics. Furthermore, 17.1% of CDSS subjects were referred to dieticians or exercise programs after diagnosis, compared to 3.9% in the control group. Evaluations for secondary causes of hypertension, lipid screenings, and the initiation of antihypertensive medications were all more common in the intervention group as well.

Overall, the implementation of TeenBP was shown to significantly increase the rate at which pediatric hypertension was identified (54.9% in the intervention group v. 21.3% in the control group) with a moderate increase in guideline-adherent management, including referrals and further diagnostic workup.[5] Authors have concluded that the effective use of this CDSS shows promise for the implementation of other CDSS that are designed to aid in the timely diagnosis of disease states that are often overlooked.

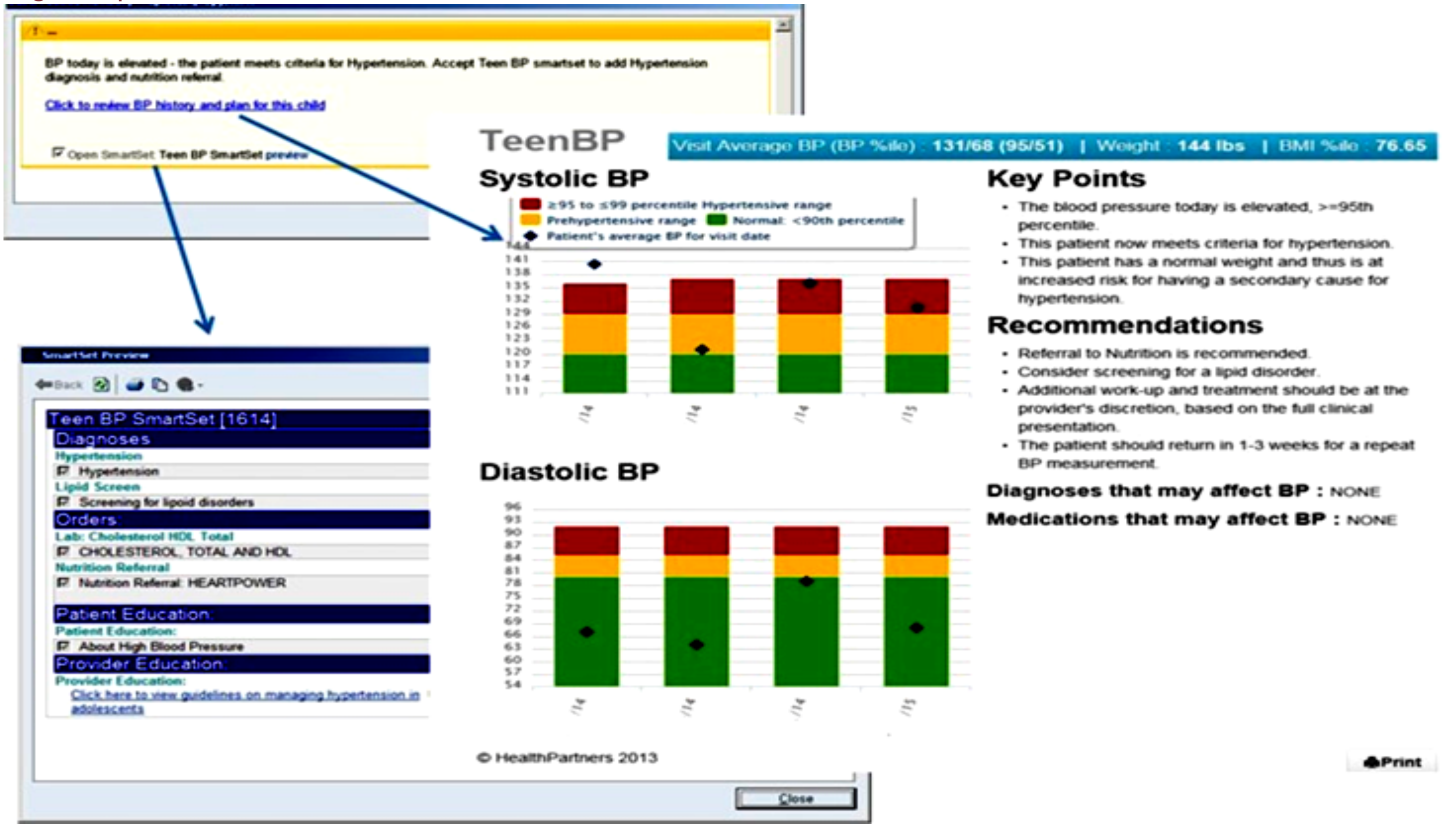
Clinical Implications

PRISM, or the practical, robust implementation and sustainability model, evaluates how an intervention interacts with recipients to influence program adoption, implementation, maintenance, reach, and effectiveness.[7] Under PRISM, the success of any intervention depends on understanding and addressing barriers to implementation. These barriers include patient perspectives on the intervention, organization perspectives on the intervention, relevant characteristics of the recipients (i.e., clinicians and patients), as well as barriers within the external environment.[3] In order to properly evaluate a study, these potential barriers must be considered.

Within the ASCVD risk-reduction study[4] failure to show a net positive effect of CV Wizard use due was impacted due to the low use rates of the system within the intervention clinics, where only 20% of the alerts presented by the system were addressed. In contrast, an earlier and non-discussed study, showed CV Wizard use rates of about 75% within a small scale group of primary care clinics.[8] While the exact cause of the widely varied results between these two similar studies cannot be determined, an understanding of PRISM can help identify the potential barriers to successful implementation. Authors of the study suggested that barriers both within the external environment and with the characteristics of recipients (in this case, the rooming staff) may have led to worse outcomes in the ASCVD risk-reduction study relative to previous studies. In addition, the authors recognized that heterogeneity in rooming protocols between the clinics impeded efforts to train rooming staff and likely contributed to decreased use of the CDSS. Moreover, since this study was conducted in community health clinics, it is also possible that staff faced greater time-constraints than their counterparts in better-resourced health care facilities. A potential way to address these barriers in future studies is to provide the CV Wizard alert directly to providers instead of rooming staff, essentially cutting out an extra step that requires communication between the two parties.[3]

In comparison, the study addressing pediatric hypertension showed more promising results, with 54.9% of patients accurately diagnosed with hypertension compared to 21.3% in the usual care clinics.[5] Although the CDSS was successful at achieving its target outcome, many patients that met diagnostic criteria remained undiagnosed at the end of study despite providers being alerted that pediatric hypertension was identified. Considering PRISM, the most likely barrier within this study applies to the characteristics of clinicians involved. The alert could have been ignored simply due to alert fatigue (a desensitization to alerts due to an over-

Figure 2 | TeenBP User Interface[5]



whelming number per day) and the lack of a "hard stop" within the EHR. As hard stops force the clinicians to address the alert and provide rationale for their response before proceeding with the visit, it is possible that any alerts that do not function as hard stops may not be taken as seriously. Additionally, it is possible that not all clinicians in the study had full confidence in the accuracy of the CDSS, leading to the alert being ignored. Finally, the physician's perception of the importance of diagnosing pediatric hypertension may also impact clinical actions. For instance, if a patient presented for treatment of an ear infection, the physician may focus solely on that and put aside concerns for hypertension until a later visit due to a perceived lack of urgency in addressing the condition.

These potential barriers present within the pediatric hypertension trial could have been partially mitigated through using a hard stop and/or an educational seminar on the importance of prompt diagnosis of pediatric hypertension. Additionally, a wider-scale integration of CDSS into daily practice may be necessary to grow physician confidence in the system and allow utilization of full technological potential.

Conclusion

Clinical decision support systems (CDSS) are powerful tools that seek to improve patient outcomes, assist clinicians with decision making, increase productivity, and improve patient satisfaction. In this review, two recent studies testing different CDSS within the primary care setting were discussed. The studies aimed to demonstrate the utility of CDSS in reducing reversible cardiovascular risk through the use of CV Wizard[4] and diagnosing pediatric hypertension through the use of TeenBP.[5] Both studies initially showed promise by introducing well-designed CDSS with novel, practical uses into the primary care setting. However, the results produced did not fully reflect the benefits the CDSS aimed to provide.

In conclusion, these findings highlight the barriers researchers are presented with when conducting studies on CDSS systems. Barriers relevant to these studies include difficulty integrating the systems into workflow, low use rates, alert fatigue, and difficulty gaining clinicians' confidence in the systems. Addressing these barriers in future studies may provide more clarity on the potential utility of CDSS in the primary care setting, and other clinical setting environments. Ultimately, more evidence showing that CDSS leads to improved outcomes is needed before supporting the wide-spread implementation of systems such as CV Wizard and TeenBP.

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