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Computerized Clinical Decision Support: The essential tool of tomorrow's healthcare provider

Pavel Antiperovitch MD FRCPC*, Anthony Tang MD FRCPC

Department of Medicine, Division of Cardiology, London Health Sciences Centre, Western University, London, Ontario, Canada

*Corresponding author: Pavel Antiperovitch, Department of Medicine, Division of Cardiology, London Health Sciences Centre, Western University, 339 Windermere Rd. Rm. C6-004, N6A 5A5, London, Ontario, Canada

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The Looming Problem in Clinical Medicine

In the last 20 years, our healthcare has faced an exponential growth in evidence-based medical knowledge, which provided healthcare practitioners with unprecedented amount of guidance on the diagnosis and treatment of diseases. In 2021, approximately 1.3 million medical publications were added to MEDLINE, which is double the amount published in 2007 [1]. With the overwhelming amount of data available to healthcare providers, and important challenge emerges - it is simply unrealistic for a modern physician to maintain updated medical knowledge, recall detailed information about any disease, and apply it to their patient. This has led to substantial variation in clinical practice and diminishing adherence to clinical practice guidelines, which directly translate to poor patient outcomes (highlighted in the Institute of Medicine 2012 report) [2].

A well-documented example of this issue concerns prescription of anticoagulation for stroke prevention in atrial fibrillation. Recent data reveals that approximately 25% of patients on anticoagulants are not on the guideline-indicated dose, which doubles their mortality from stroke and bleeding events [3]. Adherence to clinical practice guidelines is similar across many fields of medicine, and direct impact on patient morbidity and mortality is well documented [4-7]. Many barriers to guideline compliance have been identified, and numerous solutions have been proposed [8]; many include the dissemination and education of healthcare providers as well as quality improvement problems. These have been demonstrated to improve prescribing practices, but are costly and arguably do not go far enough [9,10].

What is Clinical Physician Decision Support, and How Can it Help?

One approach to tackling this problem is to leverage the power of computing to improve guideline compliance. Medical information is slowly transitioned to the digital realm as paper charts and dictated reports are phased out in favor of digital medical records and codified information. This allows us to leverage computer algorithms to deliver and implement a clinical practice guideline – this is called electronic clinical decision support (CDS) (Figure 1).

The process for creating a CDS involves careful review of medical literature and engagement of experts in the field to establish the best standard of practice, which is then communicated to software developers in a form of a care pathway (decision tree). Software programmers convert the care pathway into computer code to create a computed care guideline (CCG). These CCGs are then operationalized by incorporating them into electronic medical record (EMR) systems (Figure 1). As physicians see patients, these CCGs are executed in the background on known medical data and provide real-time point-of-care recommendations specific to the patient they are seeing. Machine learning (ML) and artificial intelligence (AI) have been trialed as backbones of CCGs, however this complexity is not required as most healthcare decisions require a simple binary decision tree. However, ML and AI are frequently used for feature extraction from complex biometric signals (such as ECGs) [11].

For example, imagine the workflow of a healthcare provider in a busy practice setting, seeing a patient with atrial fibrillation: Upon identifying the patient has atrial fibrillation, the provider performs a detailed history, physical exam, and inputs this data into the EMR. The provider must

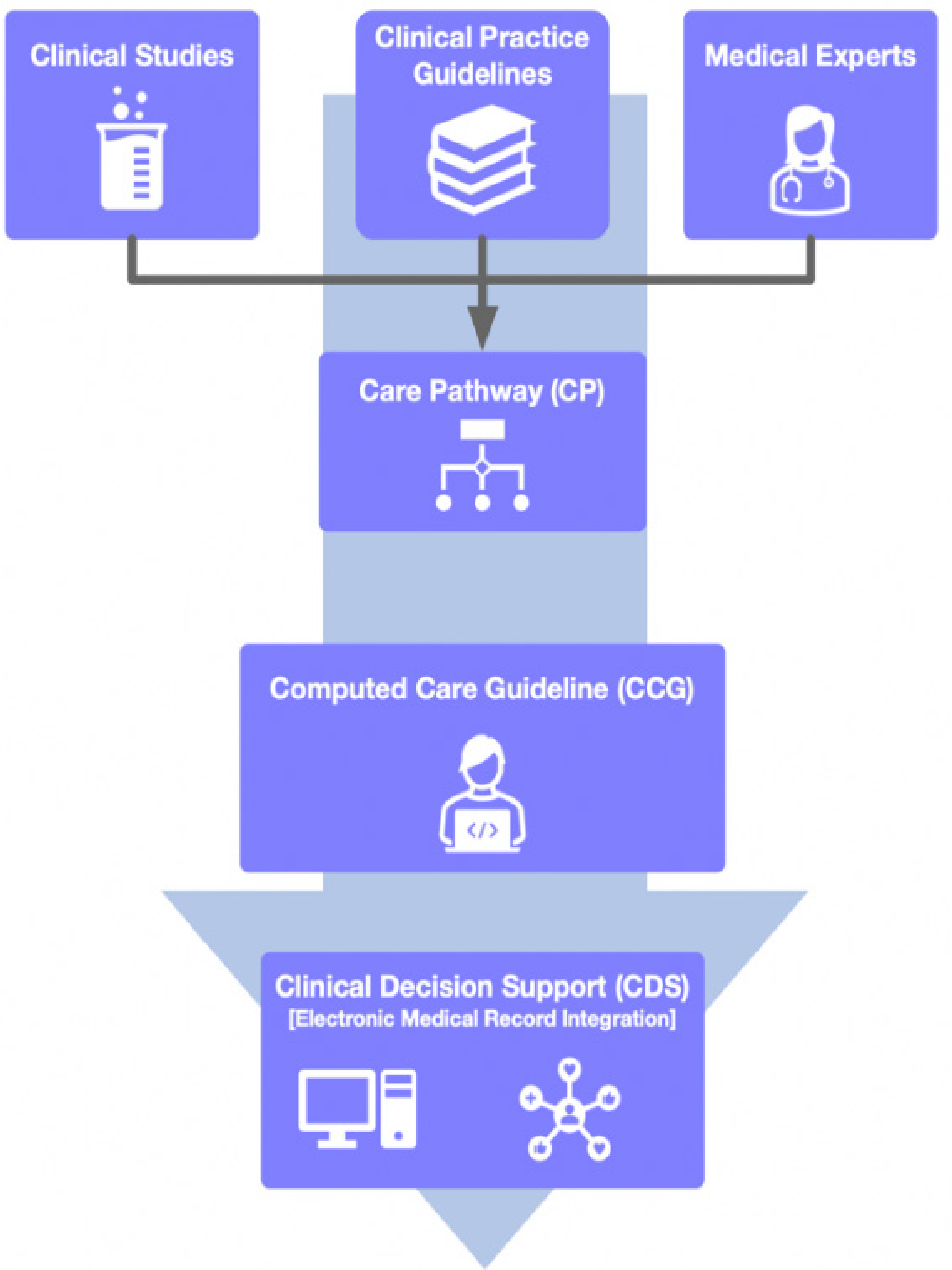

Figure 1: Definitions of a care pathway (CP), computed care guideline (CCG), and clinical decision support (CDS).

then review the most up-to-date recommendations in the latest published guidelines, calculate the CHADS-Vasc risk score, check patient's renal function, and decide on a stroke prevention medication. The provider must then review the drug product monograph of the drug and adjust the dose according to patient factors including kidney function, age, weight, then cross-check the candidate prescription against patient's list of allergies and drug interactions. If it any point the medication is deemed inappropriate, the process must be repeated. This entire process can be programmed into a CCG and executed in seconds to deliver the most up-to-date, safe, and relevant recommendation for this patient. It can save physicians hours in a busy medical practice while reducing adverse outcomes from inappropriate drug selection or dosing. These CCGs operationalize the best practice guidelines allowing non-specialist community physicians to operate at the care level of an expert physician.

What is the Benefit to Patients?

Deployment of CPGs enables clinicians to provide patients with expert-indicated and most up-to-date medical care. The CGPs themselves can be implemented in such a way that patients receive CPG recommendations directly. Making the patient aware of best practice recommendations can help engage patients to take a greater responsibility for their health, and increases the

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chances these recommendations are implemented because the patients may proactively make a physician appointment to discuss the recommendation. Personal health record systems and mobile apps can be used as vehicles to deliver recommendation to patients as well as the patient education associated with each recommendation.

Does it Work?

Real time CCGs are not a new concept and have been deployed on a small scale in several areas of medicine [12]. One famous example is sepsis management - in a landmark RCT, a CCG alerted the nurse when a patient is at risk of deterioration, which led to early intervention and improvement in mortalit [13]. Similar CDS has been used to optimize the treatment of pneumonia, and has been the first intervention in decades to improve mortality in patients hospitalized for pneumonia [14]. Outside of patient outcomes, CDS systems have been shown to improve resource utilization and cost through numerous mechanisms including reduction in medical test redundancy, shortening length of stay, and suggesting cost-efficient treatment alternatives [15,16]. One pediatric ICU was able to save $717,538 by implementing a simple CCG to reduce unnecessary laboratory testing [17].

Implementation Challenges

Development of CDS certainly requires significant amount of resources – mainly clinical, technical and management expertise along with upfront cost of development. Quality assurance must be implemented to ensure the CCG performs as expected, and continued review of medical literature must be performed to constantly update the CCG to reflect the most updated evidence-based recommendations. Furthermore, implementing CCGs requires deployment to existing EMR systems, which currently lack an agreed-upon standard of communication and the necessary coding of medical data. However, published implementation standards, such as the HL7-FHIR can assist with easy integration of CCG tools [18].

Conclusion

As our advancement in clinical science continues to accelerate, the ability of a modern physician to keep up with the rapidly changing evidence base and practice recommendations is slowly deteriorating. We must transition clinical practice guidelines into the digital realm and create an essential tool physician can use to deliver high quality evidence-based care.

Declarations of Interest

The authors declare that they have no conflicts of interest.

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