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NOVEMBER 2018 V41, NO.11

TECHNOLOGY: PART II

CLINICAL UPDATE IN CLINICAL INFORMATICS: PART III

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The Clinical Update series continues in SGIM *Forum*, covering clinical decision support (CDS) systems, with a focus on how the implementation of these systems impact clinical workflow and practitioners. Population health is also a focus of this article in the series.

Starting from the August 2018 issue of SGIM *Forum*, the previous two articles in this series were inspired by our live Clinical Update session at the 2018 SGIM Annual Meeting, summarizing clinical informatics papers published in the year prior the meeting that were relevant for general internists.[1,2] The complete methods for journal and article selection are described in the August 2018 article.[1] The structure of this article will follow the previous two in this series, starting with a vignette and subsequent discussion.

Case Vignette #1

JD is a 54-year-old female with hypertension, type 2 diabetes, and moderate persistent asthma. Her medications include hydrochlorothiazide, atenolol, insulin, albuterol, and fluticasone MDI. She presents with persistent headaches, dyspnea, and polyuria. Her temperature is 98.9°F, pulse 88, respirations 32, blood pressure 152/94 mmHg, pulse oximetry 95% on room air. Physical exam is notable for expiratory wheezes with bibasilar crackles and lower extremity pitting edema. Fingerstick glucose (nonfasting) is 300 mg/dL, and urinalysis shows 2+ ketones and glucose of 500.

Clinical Decision Support Systems

The vignette describes a common clinical scenario of a patient who presents with multiple chronic conditions, or multimorbidity, which is an increasingly prevalent and challenging condition due to potentially interacting or contradicting recommendations for each condition. This leaves the physician frequently in a difficult position when treatment of one condition can significantly impact the others.

Clinical decision support systems offer the potential to aid clinicians in the practice of evidence-based medicine with the promise of providing enhanced patient safety and quality of care.[3] However, many CDS applications exist, with a variety of features, implementations, and effectiveness. Frequently, unintended consequences are alert fatigue and nonadherence to evidence-based guidelines on which these CDS systems are based.[4] Bates, et. al., described in a seminal paper on CDS systems that a properly designed CDS system should alert a clinician about an issue related to a given patient that is "important to remember but easy to forget."[5] Furthermore, Campbell proposed the five rights of CDS:

1. **the right information presented,**
2. **to the right person,**
3. **in the right interventional format,**
4. **through the right channel, and**
5. **at the right time in the workflow.[6]**

For example, a clinical alert should trigger only if it would change the provider's decision, such as when prescribing a medication. The alert should present information in a meaningful way to the provider before the order is completed and in a manner that allows for the appropriate action to be done efficiently.

Kassakian, et al., reported on common malfunctions in CDS alerts.[4] In an analysis of a commercial electronic health record, four common categories of CDS errors were identified:

1. **medication dictionary errors,**
2. **seasonal alerts (e.g., influenza vaccine recommendations),**

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3. **database structure errors, and**
4. **edits performed on the base alert (e.g., to customize the presentation for a specific specialty or workflow).**

Solutions for most of these error types focused on sociotechnical or human factors, such as governance and knowledge management. These concepts were echoed by Yoshida et al. in their analysis of knowledge management in an institutionally-developed electronic record system and a commercial system.[7]

Discussion

The primary goal of CDS systems is to improve patient safety and quality of care by supporting evidence-based decision making at the point of care.[3] Recent studies of CDS applications focus on sociotechnical aspects of CDS, such as alert fatigue and provider burnout, rather than solely the mechanics of CDS systems.[8] In order to mitigate barriers in design and implementation, careful design and governance are important to guide developers on important and clinically relevant components of CDS systems.

Traditional approaches applying CDS as a direct translation of evidence-based medicine may have shortcomings for heterogeneous populations, such as patients like JD who have multimorbidity. Data-driven approaches, utilizing large data sets, analytic approaches, and drawing from current medical knowledge could inform the management of such populations. Such data-driven approaches are further explored in the next section on population health.

Case Vignette #2

JS is a 21-year-old man presenting with a cough for one week. He has fever, chills, malaise, myalgias and a 5-pound weight loss since his routine visit three months ago. Of note, he recently traveled to Cancun for a destination wedding. He reports that "the bachelor party was epic." Also, you have seen 5 patients today with nearly identical symptoms (although without the party history).

Population Health

This patient presents with an acute illness with a possible exposure to an infectious disease internationally. It is also possible that a localized infectious disease could be contributing, depending on the seasonal variation and other contextual features. This vignette illustrates an opportunity for information systems and public health surveillance to support point-of-care decision making and clinical judgments. Additionally, the vignette offers a potential application of population health integrated into routine clinical workflow.

Kindig and Stoddart define *population health* as "the health outcomes of a group of individuals, including the distribution of such outcomes within the group."[8] Population health systems provide cross-cutting, chronic disease and health promotion expertise at the point of care. Computerized systems facilitate management of medical information and population health data, which is illustrated by the notion of *doubling time* of medical information. Densen describes the exponential increases in medical knowledge, estimating that the rate of growth of knowledge was once every fifty years in 1950, but will be once every 73 days by 2020.[9] This means that medical residents graduating in 2020 will have experienced four sets of information doubling during their seven or more years of medical school and residency. Consequently, combining data from a variety of sources, including electronic health records, with data analytics has the potential to revolutionize the way that a population's health is managed.

Some studies reviewed demonstrated positive effects of implementing population health systems. Kooij, et al., reviewed population health technology interventions, showing demonstratable improvements in chronic disease management in home care settings but acknowledged that the findings were mixed and difficult to reproduce in the literature.[11] Also in home care, Radhakrishnan, et al., were able to apply visual data representation techniques to homebound elderly patients to identify which patients were at higher risk of medical complications such as falls.[12] With regards to breast cancer management, Finkelstein et al. showed that using a coordinated management system was better able to link providers and higher-risk patients with shared decision making tools.[13]

The variety of such population health tools are also rapidly expanding, through academic, industry and other initiatives and collaborations. Roosan, et al., demonstrated an application of these data analytic approaches to provide mathematical predictions of outbreaks, as well as provide clinicians with a visual representation of the data so that it could be easily actionable.[14]

Discussion

Infectious disease surveillance is a promising application of population health informatics, applicable in the vignette presented. The initial impression would be that this patient simply has influenza or perhaps an intestinal viral infection; however, less common but reemerging illnesses, such as Zika virus or Dengue fever, could be better detected with improved surveillance systems. In addition, local patterns and seasonal variations, could also be presented with the use of a data analytic and surveillance tools, thereby providing diagnostic and treatment support to the clinician.

Rapid collection and display of immense amounts of data and information in a meaningful way for

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clinicians could support individual patient care, guided by surveillance or predictions based on regional patterns of antibiotic resistance or data-driven treatment pathways. More broadly, population health information systems could aggregate local data to guide national interventions especially in scenarios of pandemics or bio-terrorism. However, there must be care in the interpretation of this information, given that there may be limitations in the data or inherent biases due to specific populations.

Medical information is exponentially growing, thus presenting a challenge for individual clinicians to evaluate all possibilities for patient and population health management. Through augmented health care, the conscientious applications of computerized systems combined with human capabilities and insights, this should become a far less daunting task.

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The final article in this series will focus on the use of mobile devices in both clinical care and research.

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