Clinical and Business Intelligence into Clinical Workflows
Part 3: Future Scenarios

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Source: HIMSS C&BI for Population Health Task Force

Introduction

This paper is the third in a series that explores the topic of integrating Clinical and Business Intelligence (C&BI) with operational workflows in the clinical environment.

1. The first paper in the series introduced the topic and the need for clinical and business intelligence integration into the workflow for care delivery.
2. The second paper details case studies of this type of workflow integration and the impact to the organization. The examples provided are courtesy of Geisinger Health System, a Danville, Pennsylvania-based integrated health delivery system.
3. In this third and final paper we explore future scenarios by hypothesizing how future healthcare industry trends and technology trends will open up richer clinical workflow integration scenarios.

Healthcare Industry Trends

Moving from Fee-For-Service to Value Based Care

The transition from Fee-For-Service (FFS) to Value Based Care entails moving from a primary care provider (PCP) model of care to a multidisciplinary team approach.

- **Rise of the Patient-Centered Multidisciplinary Care Team:** In the past, the PCP was the "quarterback" directing the patient's diagnostic procedures, therapies, and treatments on an ad-hoc basis. In an "at risk" model, to survive capitation the PCP and/or the health system must focus on the overall health of the population and the individual patient. Wellness care; early identification of "movers", i.e., those patients at risk of requiring costlier care that can be averted with patient engagement and / or assistance with health services navigation; chronic care

management; and acute care management are critical. Consequently, the PCP is no longer the "quarterback" but a key member of a multi-disciplinary team that may be ad-hoc in nature or formal, depending on the setting, contractual requirements, and/or the care model.

- **The Need for Care Management Triage:** Multidisciplinary care teams can be composed of a variety of specialists and community resources based upon the needs of the patient(s). Obviously, ad hoc teams formed on a patient-by-patient basis can be inefficient due to the complexity related to sharing of the patient longitudinal record, the lack of consistent communication, and the timing and coordination of diagnostic and treatment performed. A patient may be required to work with multiple care managers and providers with different perspectives and care plans. For example, a diabetic patient could be working with their PCP, an endocrinologist, a health plan care manager, a health system care manager, and a health system case manager if admitted for hospitalization for an acute episode. This requires triaging care plans and interventions by the care management stakeholders with the patient.

- **Need for Shared Decision-Making with Patients:** Patients need to be part of their multidisciplinary care team. In a FFS model, the patient was cared for by the PCP in a paternalistic fashion. The patient was informed of the benefits and risks of diagnostic procedures, treatments, and therapies. In this new model of care, the patient should be part of the decision-making process where the care plan is discussed, alternative course of care evaluated and weighted against the clinical outcomes, evidence based guidelines and prioritization of deployment, the quality of life considerations, and the cost of care.

- **The Rise of Patient Consumerism:** As patients bear a higher cost of the care they receive, they are learning to be active healthcare consumers. In addition to shared decision making, patients are demanding access to care that is convenient and fits into their lifestyle, such as retail care; are becoming more self-directed with mobile chronic care management applications and resources; and seek providers that will connect and partner with them on their ongoing care.

Emergence of Personalized Medicine

Personalized medicine is an emerging trend. Personalized medicine can be used to tailor a patient's care impacting medical decisions, practices, interventions and/or products being tailored to the individual patient based on their sensitivities to medications, predicted response to treatment, and/or risk of disease. In 2003, the Human Genome Project was completed by the U.S. Department of Energy and the National Institutes of Health. The goals of the Human Genome Project were to learn the order of the 3 billion units of DNA that go into making a human genome, as well as to identify all of the genes located in this vast amount of data. The individual genes within the long strands of DNA, and the elements that control the genes, are still in the process of being identified.

But as our knowledge of these genes and their implied impact on our health are developed, the health industry can identify those patients eligible for clinical protocols, tailor treatments based on evidence based guidelines related to the patient's unique DNA profile, and target medications based on demonstrated efficacy for specific gene sequences.

Technology Trends

Hardware Advances

Hardware advances in both data storage and compute power form the basis for the fuel that drives much of the technology growth within all industries, not just healthcare. The well-known "Moore's Law"[1] still continues to this day and without this fundamental yearly increase in capability, much of the rest of the technology drivers would not be possible. Whereas 'mainframe' systems 20 years ago would have disk storage systems of one terabyte, that sort of disk storage is now commonly found on personal computers. Advances in data processing speed (Solid State Disks or SSDS, in-memory computing) and storage capabilities (distributed storage, parallel processing and data compression) in the cloud has enabled faster processing of larger data sets.

Data Growth

A direct result of the hardware growth is data growth. While the electronic medical record (EMR), and its resulting repository of all patient data, has been a focus for the healthcare industry, it is not just EMR's that will drive data growth. Imaging systems, as one example, typify the sort of system that will continue to drive growth of data outside of the EMR. New data types such as social data and genomic data already are and will continue to contribute to the growth of data storage growth. In addition, streaming data sets from remote monitoring devices, monitors at the care setting and other connected / mobile devices will tremendously increase the volume, variety and complexity of the data.

This explosive growth of data will bring additional challenges of standardization and normalization needed to enrich the LPR and making the right information is available to the care givers at the right time at the point of care. Systems with capability to process, integrate data and present relevant information ('separate the wheat from the chaff') at the point of care will enable inferring 'behind the reasons for visit' at the care setting, guiding care givers on personalized care plans.

[1] See https://en.wikipedia.org/wiki/Moore%27s_law

The New 'Connected' Care Setting

The new era of a connected care setting will include enhanced integration and communication (through standardized protocols) among care systems, remote monitoring devices and medical equipment/devices that monitor the patient's clinical parameters in the care setting. Advances in clinical decision support will include software that can integrate and process these data sets and alert care givers in real-time.

Software Advances

The transition from 'predictive' to 'prescriptive' analytics will be enabled through advances in software algorithms that process and analyze data and integration of the outputs into clinical workflows in the EMR and/or other care systems. Significant progress made in natural language processing (NLP) and machine learning technologies will further enhance capabilities for prescriptive analytics.

Integration

As systems evolve, the need for more and more integration between systems increases. It is a well-recognized challenge that the patchwork of systems which constitute US based healthcare IT need to be integrated to drive innovation and growth within the industry. We should expect to see further developments such as FHIR and other techniques that will give healthcare systems the same level of interoperability that is common in other industries.

From Business Intelligence to Artificial Intelligence

While this series of papers starts with the idea of business intelligence (BI), it should be noted that continued advances in software are now driving artificial intelligence (AI) as a logical extension and evolution of BI. While AI has long over promised and under delivered, new AI based systems and techniques are opening up new solution areas.[2] Although the need for reporting, visualization, and analytics (aka BI) will not go away for a long time, coupling these capabilities with the advanced capabilities of artificially intelligent systems will allow new use cases for future systems.

Mobile and Pervasive

More and more mobile and pervasive devices have driven the term "the internet of things" (IOT). In IOT, every device gets internet connectivity and new solution areas become possible for the healthcare industry. Some of that is already the case with home based devices such as a weight scale or a glucometer; we should expect to see more in this arena.

[2] See http://insights.wired.com/profiles/blogs/the-ai-resurgence-why-now#axzz42QtV5oeV

Future Integration Scenarios

The Patient

Bruce is a former smoker living alone with obstructive pulmonary disease (COPD), congestive heart failure (CHF), and diabetes. Bruce has a PCP who is part of the Acme Health System (AHS).

A Typical Patient Experience Today

Bruce sees his PCP once a year and knows he has COPD, congestive heart failure CHF, and diabetes but does not really follow his PCP's guidance. Bruce gets communication from his PCP's practice periodically as a reminder to see his PCP and seek wellness care, but his health continues to deteriorate. Bruce's care management consists of separate disconnected workflows of various clinicians. He has other specialists but none of them talk to each other or his PCP.

During the summer, the temperature in Bruce's apartment soars. Without air conditioning, Bruce's COPD is exacerbated. Due to his hypoxia, he has difficulty preparing his meals and his blood sugar plummets. Bruce is found by a maintenance man in his apartment unconscious. He is brought to the hospital via ambulance and admitted to the ICU via the Emergency Department.

Post discharge from the hospital, Bruce is being cared for by a home health agency three times a week. The nurse visits Bruce once a week and notes that he has gained weight due to his Congestive Heart Failure. However, due to the delay in identification of the issue, Bruce is readmitted to the hospital for oxygen therapy and diuretics.

A Future Care Integration Scenario

AHS is implementing a new model of care to manage CHF and diabetic patients. While in the past they have been able to identify those patients, they now want to actively engage and manage those patients to improve the quality of care delivered, enhance patient engagement and outcomes, and reduce the cost of care. Described in Table 1, in the new model of care, patients like Bruce are assigned a multidisciplinary care team that has optimized care coordination, communication, and processes built into the workflow of the disparate providers:

TABLE 1. C&BI Workflow Integration in the Patient Event of the Future

Scenario	Healthcare Implications	Technology Implications
Population Health Analytics, Care Management Triage		
The care management team does an analysis of the AHS patient population. As part of the result of that analysis, Bruce is placed in a high risk category for follow up with a care management team.	Early identification triage of high risk patients and/or "movers" in the population can enable early intervention that is more impactable.	Systems integration has allowed AHS to set up a system whereby the LPR now contains data from many disparate systems.
Longitudinal Patient Record		
Bruce's providers analyze his longitudinal patient record and identify that he is at risk of exacerbation of his CHF during the summer months due to his housing and non-compliance with his care recommendations.	The patient's longitudinal record provides a timeline view of events. Identifying the triggers that are resulting in inappropriate use of the Emergency Department and admissions to the hospital can help the patient's care team initiate interventions to prevent incidents. In this example, the lack of air conditioning in Bruce's apartment exacerbates his CHF. This is further compounded by the fact that Bruce is not compliant with his oxygen therapy and does not weigh himself regularly. As a result of being out of breath and water weight gain due to his CHF that further taxes his body, Bruce is often found unconscious or despondent resulting in emergency admissions in the summer months.	Hardware advances allow the health system to economically store massive amounts of data in the longitudinal patient record. The data streams in not just from AHS, but other relevant sources as well.
Multidisciplinary Care Team Management, Shared Decision Making		
Bruce's multi-disciplinary care team meets with him via a telehealth tool and discusses care plan options and his ongoing health status.	Bruce's multiple comorbidities are best addressed by a multidisciplinary team that works in a coordinated manner to prioritize care and engage Bruce. Previously Bruce had to meet with multiple doctors for his various conditions with sometimes conflicting medication regimens. Furthermore, that fragmented approach delayed his care, was episodic in nature, and incurred mobile ambulette costs that are	A pervasive home based telehealth solution allows Bruce to communicate with his care team.

Scenario	Healthcare Implications	Technology Implications
	now not necessary with telehealth delivery.	
Personalized Medicine		
Based on Bruce's genetic profile, socioeconomic status, mental health status, and reluctance to engage in this early stage of care intervention, the team prioritizes their care plan recommendations based on trumping logic on the care plan recommendations. The team can see trending of Bruce's health over time and guidance is also offered by the system through AI agents that have been harvesting the patient data for advanced insights.	Personalized care management of the patient allows for better patient engagement and a focus on the diagnostics and care that are the most impactful for better patient satisfaction and compliance, and near-term and long-term outcomes.	BI systems compliment the EHR and LPR views that the clinicians use on a day to day basis. The business intelligence systems not only display trends but have calculated scores that measure various aspects of patient health and risk.
Patient Consumerism		
Bruce is initially focused on eating five small meals a day to address his diabetic issues and weighing himself daily. When he fails to step on his scale for three days and/or gains five or more pounds, his nurse and PCP are alerted immediately for intervention. Diuretics are prescribed and the frequency of nursing visits are increased until the issue is resolved while Bruce remains in his home.	Shared decision making is key to effective care management. But alerting systems to monitor compliance both motivate patients to comply long-term and alert care managers when compliance is lagging for whatever reason. In Bruce's case, he may not weigh himself in the summer as often as he should because he is bedridden due to the oppressive heat and humidity in his apartment and being out of breath.	AI now compliments the BI by offering agents that will help guide clinicians in their decision making.

Conclusion

Integration of clinical and business intelligence into the clinical workflow combined with the power of personalized medicine, patient consumerism, and shared decision-making hold a great deal of promise for the future. The migration from Fee-For-Service to Value Based Care models will only accelerate the adoption of technologies that leverage the power of Big Data and enabling technologies.

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