**IT601- Research Topics**

**Predictive Analytics in healthcare: Promise and potential**

**Abstract:**

The healthcare industry historically has generated large amounts of data, driven by record keeping, compliance & regulatory requirements, and patient care (Raghupathi, 2010). While most data are stored in hard copy form, the current trend is toward rapid digitization of these large amounts of data. Driven by mandatory requirements and the potential to improve the quality of healthcare delivery meanwhile reducing the costs, these massive quantities of data (known as ‘big data’) hold the promise of supporting a wide range of medical and healthcare functions, including among others clinical decision support, disease surveillance, and population health management (Burghard et al., 2012). Predictive analytics is the use of data, statistical algorithms and machine learning techniques to identify the likelihood of future outcomes based on historical data. The goal is to go beyond knowing what has happened to providing a best assessment of what will happen in the future. It makes it possible to harness the power of big data to improve the health of patients and lower the cost of health care. Predictive analytics encompasses a variety of statistical techniques from predictive modeling, machine learning, and data mining that analyze current and historical facts to make predictions about future, or otherwise unknown events (Encyclopedia WTF). In medicine, the convergence of meaningful use of electronic medical records, ICD-10 diagnostic coding, data warehouses, and integrated healthcare systems are bringing such predictive analytics to the bedside and clinics in order to improve the health of the nation. The U.S. is investing a significant amount of resources into the informational technology infrastructure with the intent of harnessing such big data to help predict, diagnose, and treat medical conditions and thereby improve population health (Ustun et al., 2016).

The paper describes the nascent and fast-evolving field of Predictive Analytics in healthcare, provides a broad and general overview of Predictive Analytics for healthcare practitioners and researchers.

Amazon’s success has mainly been credited to the early adoption of

innovative business ideas and state of the art technologies. They also seem to have realized

the potential of big data by filing a predictive order fulfillment and logistics patent

that practically has no delivery lead times as data mining helps Amazon determine what

potential customers may end up buying and shipping products in their general direction

even before they have finalized their purchases (Spiegel et al. 2013). Similarly, Wang et al.

(2016) noted the usefulness of big data for determining market trends and customer buying

patterns which enables a closer match of supply with demand and therefore, lowering

supply chain costs. Studies such as Dubey et al. (2016) have put the potential benefits of

using big data in analyzing operations management and supply chain activities to 15–20%

increase in return on investment (ROI), productivity and competiveness. This underscores

the importance of data mining and predictive analytics for more informed decision making

in the realm of operations and supply chain management (Papadopoulos et al. 2016).

There seems a near consensus that data mining and predictive analytics have provided

an innovative way of improving the supply chain processes and the businesses need to

proactively embrace big data to stay competitive (Waller and Fawcett 2013; Hazen et al.

2014).

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Lessons From Other Fields

Other industries have successfully used predictive analytics to tailor service delivery in real time. Familiar examples include Amazon’s product recommendation system for online shopping based on an individual’s prior purchases, and American Airlines’ ticket pricing system based on prior customer purchasing trends. Sports teams like the Oakland Athletics have relied heavily on analytics to select player rosters, outperforming expectations despite having a much smaller payroll than other teams. These organizations use large amounts of data and sophisticated machine learning algorithms to meet consumer and organizational needs. In health care, predictive analytics offers an automated means to forecast future health outcomes for individuals or populations based on algorithms derived from historical patient data. Some smartphone apps have successfully applied predictive analytics to influence health care: Ginger.io, for example, uses analytics based on cell phone data to identify patients at risk for depression crises, cueing physicians and caregivers to intervene.2 As more electronic health data become available, some health systems have begun to develop predictive models around clinical issues, such as acute intensive care unit decompensation and hospital readmissions.1

As organizations like Amazon and American Airlines have shown, however, development of these models is only a first step. Few health systems currently use predictive analytics at scale to influence health care delivery. Health systems must identify strategies to implement predictive risk algorithms into clinical practice

Using Predictive Analytics to Focus Intensity of Services Across the Care Continuum

Acute Care Antibiotic overuse predisposes patients to adverse events and resistant infections, the treatment of which results in significant health care costs in the United States. Kaiser Permanente of Northern California (KPNC), an integrated health service organization, has used predictive analytics to reduce antibiotic overuse in neonates. KPNC used maternal health datafrommorethan600000livebirths to determine the probability of early-onset neonatal sepsis in non-premature infants prior to birth. These data were integrated with objective clinical data from the new born at birth to assess the probability of sepsis by categorizing newborns as at low, medium, or high risk of sepsis. KPNC obstetricians and neonatologists then used this score to determinewhethertoadministerantibiotics.3Afterimplementation of this algorithm, use of systemic antibiotics in

theneonatalperiodamongnewbornsof34weeksormore gestationwasestimatedtodecreaseby33%to60%,and up to an estimated 250000 newborns nationally could potentially be spared antibiotics at birth annually.3 Post discharge Care Hospital readmissions represent an important driver of spending, with all-cause 30-day readmissions costing the US health system more than $41 billion annually, and thus are a major quality indicator for health systems.4 Parkland Health and Hospital System used an algorithm based on 29 clinical, social, behavioral, and utilization factors available within 24 hours of admission to predict risk of readmission for patients with heart failure.5 In a prospective study, 228 patients with heart failure deemed at high risk of 30-day readmission received targeted evidence-based interventions including (1) detailed patient education by a multidisciplinary team including a pharmacist, nutritionist, and case manager; (2) follow-up telephone calls within 48 hours to ensure medication adherence; (3) outpatient heart failure specialist appointments within 7 days; and (4) a primary care appointment scheduled according to the urgency of non-cardiac issues. Compared with 834 patients enrolled in the study prior to intervention, there was a 26%relative reduction in risk-adjusted odds of readmission among 913 patients with heart failure enrolled in the post intervention period (26%vs 21% 30-day readmission rates).5

**Concerns**

Some health professionals have raised concerns about the application of predictive analytics, not the least of which is the perceived diminution of the role of the physician in managing clinical uncertainty.8 Other concerns include protection of patient privacy, diminishment of patient preferences, and inadequate medical training.9 Health professionals had similar hesitations more than a decade ago when considering implementing EHRs. However, algorithms routinely outperform practitioners’ clinical intuition without decision support. Algorithms also may enhance the quality of interaction between physicians and patients— for example, machine earning algorithms based on retrospective data can provide survival projections that may help inform discussions regarding end-of-life care for patients with advanced cancer. However, physicians will still need to exercise clinical judgment, and with appropriate training can combine new insights learned from predictive analytics alongside patient preferences to make higher-value treatment decisions.

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Predictive Analytics And The

Practice of Medicine

The use of predictive analytics has accelerated in numerous industries in the past decade, with the emergence of real-time electronic data sets so large and complex that traditional data-processing tools have proved inadequate. With the advent of the EHR, it has become possible to apply predictive analytics to health care. The use of predictive analytics in health care leverages decades of work in statistics, computer science, and clinical decision support. In this emerging era of big data, predictive analytics models can use a variety of current or historical information such as claims, clinical, social, and genomic data to make predictions about the future. The early use of predictive analytics models in medicine has focused on identifying patients at high or low risk for serious complications or adverse clinical events, preventing those adverse events, and optimally allocating scarce clinical resources. The most common example is identifying patients at high risk of hospital readmission.

(I. Glenn Cohen, Ruben Amarasingham, Anand Shah, Bin Xie, Bernard Lo July 2014)

In 2009, the Secretary-General of the United Nations (UN), Ban Ki-moon started the *UN Global Pulse (UNGP)* initiative, with the explicit goal of harnessing big data technology for human development [13]. The Global Pulse program is aimed at forming a network of innovation centers, called the *Pulse Labs*, all over the world. Ideally, these Pulse labs will bring together people from different fields of life together to make use of the free and open source computing methods/ software toolkits to analyze data to help the development and humanitarian operations especially in the developing countries. In [14], Kirkpatrick, the director of the UN Global Pulse innovation initiative, presents the case for deploying big data techniques and analytics in the field of human development. It is highlighted that data—especially from mobile phone and social media—can be utilized in fighting hunger, disaster and poverty. This report talks about “data philanthropy” where the companies, whose businesses revolve around data, can collaborate with the UN in predicting imminent humanitarian crises and help take possible steps to avoid situations that can lead to disasters.

In the developing countries, the farmers are often less informed about the soil conditions, extreme changes in the weather patterns, plantation, topography and access to markets [12, 37, 38]. Data collected from different sensors, satellite imagery and field experts can be analyzed and predictive models can be formed. Based on these models the most relevant information can then be sent using cellular network to individual farmers.

Big data analytics in healthcare is bringing a huge cultural change in the way conventional medical diagnosis and treatment operates. Big data can revolutionize medical diagnosis by integrating data gathered from various medical records of a patient, as well as real time wearable sensors, to analyze and diagnose the patient’s current health status and provide an early warning sign if the health of a patient is on a dangerous track. Doing this helps in taking preventing measurements to diagnose and treat a potentially harmful disease during early stages. In terms of making treatment more efficient and convenient, it is possible for a person having a smart phone to access medical service providers via a healthcare app [39] to obtain quick and more personalized response from the convenience

of one’s home.

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