# BIG DATA AND ADVANCED ANALYTICS FOR HEALTHCARE

The use of Big Data and advanced analytics to achieve the Triple Aim in healthcare has strong industry support and promise. Heathcare organizations are seeking to deploy these capabilities to improve clinical insights, operational effectiveness and situational awareness associated with key indicators and events. Advanced analytics are required to exceed future standards of care, provider experience and patient engagement expectations. Big Data solutions and advanced analytics are necessary to confront the massive transformation currently occurring in the healthcare industry — a transformation focused on unleashing health data to facilitate exchange with providers, payers, and patients. Disparate clinical and operational applications create the need to aggregate healthcare data in a new analytics environment for low latency collection, processing and analysis. This platform will ingest and process data streams from clinical and operational systems, perform complex event processing (CEP), pattern matching and anomaly detection, apply on-demand and continuous analytics and trigger notifications and alerts based on an embedded rules engine. The platform will also aggregate at-rest retrospective data and other source systems with real-time data streams for enhancing the context of information presented through operational business intelligence.

The drivers of adoption for Big Data deployments in healthcare will be key stakeholders who can articulate the clinical, operational, and business value. With basic understanding of how Big Data can support and improve their patient care outcomes, decrease the cost of care and provide value, the ground swell for its use will emanate from clinical, financial, and administrative personnel. Successful use of Big Data to improve health care delivery and outcomes will require a multi-disciplinary approach, strong leadership and active participation from all stakeholders to achieve the Triple Aim.

Within the realm of inpatient hospitalization and by extension, outpatient care, we offer the following four scenarios that represent examples of typical
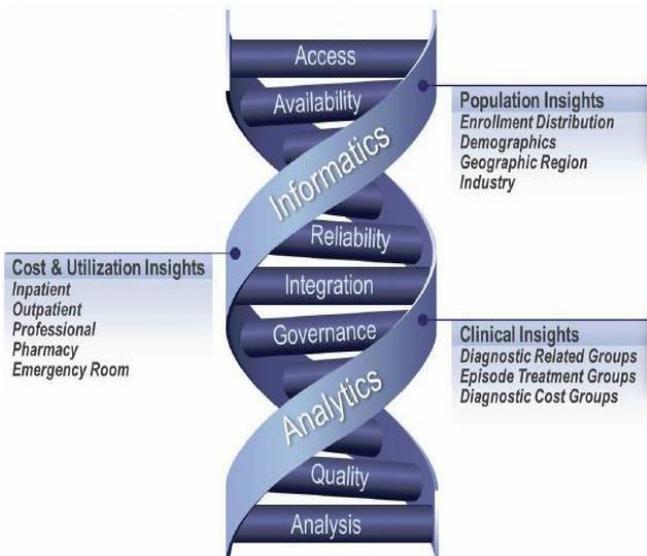
The DNA of Healthcare Data

'high cost patient care'[1]; a brief rationale for their selection is noted.

Congestive Heart Failure

Rationale:

- Patient adherence to a clinical CHF regime is difficult often requiring multiple hospitalizations for stabilization of the patient's chronic symptoms.
- CMS is curtailing payments for CHF readmissions within 30 days of the last CHF hospitalization causing a significant negative revenue impact for provider organizations.
- Meaningful Use Stage 2 requires creation of a 'Continuity of Care Document' (CCD) summarizing, via discrete data elements, the hospitalization, treatments received, discharge medications, discharge plans/problems and discharge teaching. Further, the ability to send the CCD electronically across the patient-defined circle of care is also required.

Scenario:

Mr. Jones, a 62 year old male, arrived in the ED with shortness of breath, swelling of his ankles, and extreme fatigue. There is no primary care provider caring for the patient, mainly because Mr. Jones has been out of work for 8 months and cannot afford outpatient visits. He reports smoking 1-2packs per day since high school. Family history reveals his father died of 'heart problems'. Vital signs are taken; an elevated blood pressure, 180/94, a rapid respiratory rate, Resp 24, and a weight more than 20% greater than his ideal weight were recorded. After initial lab and x-ray tests are completed, Mr. Jones is admitted for suspected onset of Congestive Heart Failure.

As a newly diagnosed CHF patient, follow up care during the first 3-5 days post hospitalization will set the tone for Mr. Jones future involvement in his care. His financial situation and lack health care insurance may make him a candidate for a program providing at-home electronic monitoring tools and review of his regularly submitted electronic weight and blood pressure readings by a program clinician. Mr. Jones' tailored CHF program and health coaching from the program clinicians

will decrease the likelihood of a re-admission within 30 days, and a curtailment of payment to the hospital. [2] (Note: Average cost in 2009 for initial CHF hospitalization = $11,000; average CHF readmission cost = $13,000.)

The patient's clinical data resides in multiple databases, including but not limited to: the hospital's EMR, the monitoring programs, pharmacy clearinghouses, and community health clinics. Financial and payer data also exist in separate databases.

Clinical questions of interest:

- Are the patient's blood pressure and weight within recommended guidelines?
- Have medications been refilled? If not, what clinical changes are being experienced?
- Has there been a 3-5 pound weight gain in the past 24 – 48 hours? If so, can the patient be scheduled to be seen in the clinic immediately avoiding a hospital re-admission?

Multiple chronic disease states – Obesity, Diabetes Mellitus Type II, Renal Insufficiency

Rationale:

- Patients with chronic diseases are living longer – all are chronic diseases and are often occur as a patient ages.
- Diabetes Mellitus Type II, (also known as: Adult Onset Diabetes, or Type II Diabetes) has reached epidemic proportions in tandem with the obesity epidemic. Total expenditure for diabetes care in 2012 was estimated at $176 billion in direct medical costs and $69 billion in reduced productivity. [3]
- Poorly or uncontrolled blood glucose results in damage to the circulatory system particularly affecting the renal system.

[1]Bates, D., Saria, S., Ohno-Machado, L., Shah, A., & Escobar, G. (July 2014). Big Data in Heatlh Care: Using Analytics to Identify and Manage High-Risk and High-Cost Patients. *Health Affairs* , 1123-1131.

[2] http://www.beckershospitalreview.com/quality/6-stats-on-the-cost-of-readmission-for-cms-tracked-conditions.html

[3] http://care.diabetesjournals.org/content/36/4/1033.full

- Financial status, lack of health care insurance and employment status impact availability to purchase medications, syringes, and glucose testing strips.

Scenario:
Mindy Odell, a 48 year old, Type II Diabetic with intermittent renal insufficiency resulting from her diabetes arrives at the ED. She is well known to the emergency department staff. She reports feeling extremely tired, frequently irritable, and recently has noticed swelling of the ankles. Ms. Odell reports she has been unable to take a home blood glucose reading for the past week because she ran out of monitoring strips and didn't have the ability to purchase more. She has been non-compliant with her prescribed medication regime and diet due to lack of test strips. A bedside test result indicated a blood glucose level = 632.

After lab results are reviewed, she is admitted to the hospital with diabetic complications, elevated blood pressure and renal insufficiency.

Multiple databases hold pertinent clinical data for Ms. Odell's care. Ms. Odell's visit history at the Diabetic Clinic, EMR visit data, quarterly lab hemoglobin A1C(HbA1C) results reported by a commercial lab, electronic daily results from her home glucose monitor, weights taken at home on an electronic scale capable of transmitting weekly readings to the clinic and pharmacy clearinghouse information. Big Data could provide customized diabetic education and enable information sharing and communications across the patient-defined Circle of Care for Ms. Odell

Clinical questions of interest:
- What is the % of change in the hemoglobin A1C result from the last available test result?
- What is the trend of renal function compared to hemoglobin A1C results?

Prevention of Adverse Event – infection/Systemic Inflammatory Response Syndrome (SIRS)

Rationale:

SIRS is a pre-condition for the more critical condition, sepsis. "Sepsis arises when the body's response to an infection damages its own tissues and organs. It can lead to shock, multiple organ failure, and death, especially if it is not recognized early and treated promptly."[4]
- Sepsis infection rates are monitored by CDC, state health departments and CMS.
- Identifying and treating a patient meeting 2 or more SIRS criteria can prevent the more extreme and life threatening infectious state, sepsis.
- In 2008 US spent $14.6 billion treating sepsis[4]
- Key initiatives to prevent both sepsis, and infections caused by the introduction of a catheter to assist treatment/medication administration are tracked by the Meaningful Use criteria.

Scenario:
Lyle Lester is a 25 year old male, who was involved in a motor cycle accident while on his way home from work. He is admitted to the ED with multiple abrasions, lacerations and an open fracture of his left leg. Mr. Lester is scheduled for emergency surgery. His abrasions and lacerations are cleaned and dressed prior to surgery. An intravenous catheter is inserted for the administration of medications during surgery; a urinary catheter is placed in his bladder prior to surgery, and the recommended dose of antibiotics is administered 30 minutes prior to the start of surgery according to hospital protocol. Following surgery, Mr. Lester is admitted to the hospital for post-operative recovery.

The first day following surgery, Mr. Lester's vitals are stable, the urinary catheter is removed, abrasion and laceration dressings are changed, and his pain is controlled with narcotics. Day 2 there is a slight elevation of his temperature, a 15 point decrease in his diastolic blood pressure and a decrease in his urinary output. His morning white blood cell count is elevated and a repeat of the test is ordered for the evening. Mr. Lester's pulse and respiratory rates increase, as does the evening WBC count.

---

[4] http://www.world-sepsis-day.org/?MET=SHOWCONTAINER&vCONTAINERID=11

Real time data[5] is needed to evaluate Mr. Lester's condition against the SIRS evaluation guidelines. A SIRS dashboard presenting a comparison of the patient's values against the SIRS criteria would provide a quick reference for the nurse as well as triggering notification to the charge nurse and covering hospitalist of the presence of SIRS criteria for the patient. Medical interventions can be initiated early.

The early identification of patients meeting SIRS criteria and prioritization of their treatment will both reduce morbidity and mortality as well as save costs and resources.

Clinical questions of interest:
Does the patient meet the criteria for SIRS? SIRS criteria are met when 2 or more of the following conditions exist:
- Temperature greater than 38 C (100.4 F) or less than 36 C (96.8 F)
- Heart rate greater than 90 beats/minute
- Respiratory rate greater than 20 breaths/minute, or PaCO2 less than 32 mmHg
- WBC greater than 12K/mm^3, less than 4K/mm^3, or greater than 10% immature cells

Health Information Exchange – Outpatient Treatment Failure –Behavioral Health

Rationale:
- Mental Health insurance benefits are difficult to obtain
- Mental Health resources – both inpatient and outpatient services are scarce.
- Depression is a contributing factor for migraines, back pain, gastro-intestinal disorders, arthritis, asthma, cancer, cardio-vascular disease, diabetes and obesity[6]
- Highly publicized incidences – Naval Annex shooting, Virginia State Senator's son, Sandy Hook Elementary

Scenario:
Daniel Martin, a 32 year old, former Army sergeant who served 2 tours in Afghanistan, suffered a trauma brain injury from a roadside bomb explosion during his second tour. This ended his active duty military service. Upon his return home, he was diagnosed with Post Traumatic Stress Disorder (PTSD) in addition to the traumatic brain injury from the blast. These disease states limited his ability to hold a job for more than a few months at a time. He often suffered from migraine headaches and sleep disturbance. He was receiving treatment from the Veteran's Administration Hospital located 200 miles from his home. His treatment plan included daily medication regime and monthly visits to the PTSD clinic at the VA Hospital. Traveling 200 miles to VA Hospital became onerous for Mr. Martin limiting the frequency of his visits and timely refills of his prescription medications. After a lapse of a few months in his prescribed treatment schedule, his intermittent employment history and financial stresses triggered a violent argument with his wife. Mr. Martin's ensuing rampage resulted in the deaths of others. Mr. Martin received a life sentence for his actions.

Integration of smart phone technology and a currently available VA application for daily assessment of patient's perceived mental health status[7] may have alerted both the patient and the PTSD clinic of the patient's failing coping mechanisms. Information contained in the VA's EHR, patient appointment system and pharmacy system databases could have alerted the PTSD clinic and provider of the first and subsequent missed appointments and his failure to refill prescriptions averting the loss of life, a life lost to incarceration, and the costs associated with incarceration. "The fee to cover the average cost of incarceration for Federal inmates in Fiscal Year 2011 was **$28,893.40**. The average annual cost to confine an inmate in a Community Corrections Center for Fiscal Year 2011 was **$26,163**."[8]

---

[5] http://www.healthcareitnews.com/news/mayo-clinic-launches-bedside-analytics?mkt_tok=3RkMMJWWfF9wsRonvqTPZKXonjHpfsX56es tXqC1lMI%2F0ER3fOvrPUfGjI4ARMRqI%2BSLDwEYGJlv6SgFQ7L HMbpszbgPUhM%3D

[6] http://www.cdc.gov/pcd/issues/2005/jan/04_0066.htm
[7] http://www.ptsd.va.gov/public/materials/apps/PTSDCoach.asp
[8] https://www.federalregister.gov/articles/2013/03/18/2013-06139/annual-determination-of-average-cost-of-incarceration

To Learn More…

Contact: Michael Joseph
Managing Partner
703.861.9897
mjoseph@primedimensions.com

www.primedimensions.com

   @PrimeDimensions