

Data Analytics Role in Population Health Management

Anthony J. Alsleben

The College of St. Scholastica

Project Committee:

David Lucia, Ph.D., Capstone Sponsor

Joanne Smith, M.A., Second Reader

Approved: May 15, 2016

Submitted in partial fulfillment of the requirements for the degree of Master of Business Administration and Master of Arts in Management. The College of St. Scholastica, St. Cloud, MN.

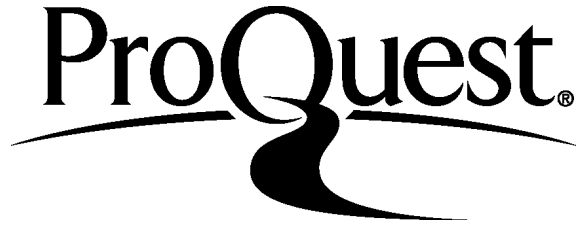
ProQuest Number: 10125300

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 10125300

Published by ProQuest LLC (2016). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

Acknowledgement

I sincerely want to thank all I have come in contact with at the College of St. Scholastica in my journey to complete this degree. I have thoroughly enjoyed the experienced conversations with the staff and students, making this one of the best learning experiences of my life.

Especially instrumental in my journey has been my wife Anna and my children, Evan, Annika, and Ella, who pushed me forward in all of my education and I thank them for that. I also want to thank David Lucia for assisting me as my capstone sponsor and supporting me through the process of writing this paper.

Abstract

This project presents a conceptual model organizations could follow to increase patient quality while transitioning to a value-based payment model. There are many changes within a healthcare organization to get to the point of efficiently using healthcare data to increase patient outcomes. The model presented in this project is directed at healthcare organizations looking to transition to a value-based reimbursement structure, while using data analytics to implement a more proactive population health strategy. The suggested implementation plan provides guidance to management and care teams as to the process of identifying an appropriate data analytics solution, and the structure needed for its use. Guidance is provided within this model to steer an organization on a path to being successful in their use of data analytics to increase the health of their patient population.

Key Words: population health management, data analytics, healthcare reform, risk stratification

Table of Contents

Introduction.....	6
Purpose.....	6
Problem Statement.....	6
Need for the Project.....	8
Overview of the Project.....	9
Literature Review.....	10
United States Payer Systems.....	10
Medicare.....	10
Medicaid.....	12
Private payers – Managed care plans.....	13
Summary – Payer Systems.....	14
Healthcare Reform.....	15
American Recovery and Reinvestment Act of 2009.....	16
Health Information Technology for Economic and Clinical Health Act.....	16
Health Insurance Portability and Accountability Act of 1996.....	17
Meaningful Use.....	18
Medicare quality programs.....	19
Healthcare Data Analytics.....	22
Data sources.....	23
Data warehouse.....	25
Data analysis.....	26
Reporting.....	27
Care Management.....	27
ACO care teams.....	28
Application.....	29
Aggregate the Population.....	30
Risk Stratification.....	30
Care Management.....	31
Patient Outreach.....	32

Review Results.....	32
Discussion	33
Implementation	33
Care team	33
Data analytics.....	34
Risk stratification.....	35
Care management.....	35
Patient outreach	36
Review results.....	36
Measuring Success of the Model	37
Limitations	37
Technological issues	37
Data issues	38
Care workflows.....	38
Future Research	39
Conclusion	39
References	41

Data Analytics Role in Population Health Management

Introduction

Purpose

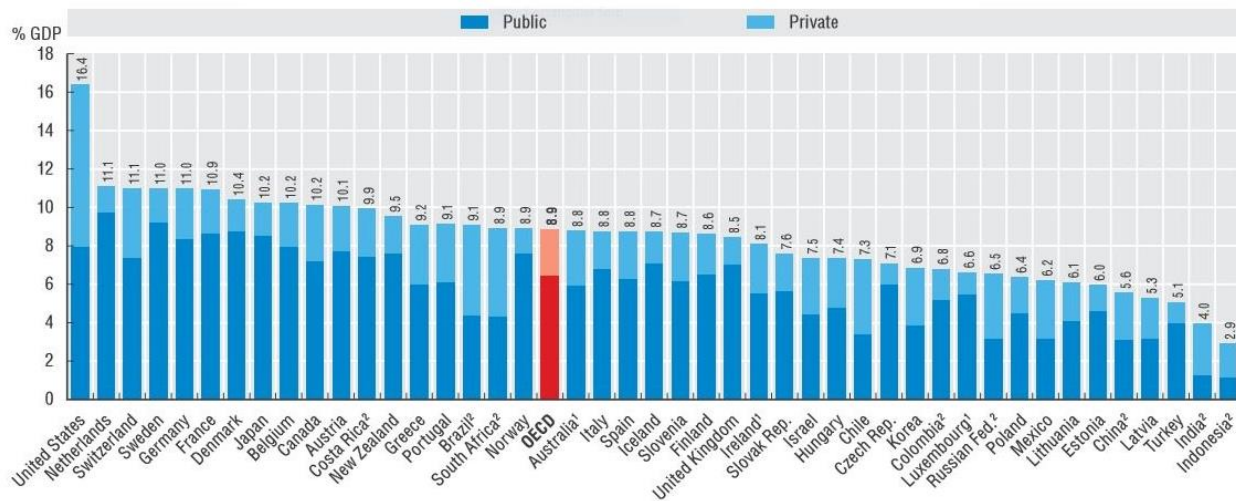
The purpose of this project is to develop a conceptual model for healthcare management use of data analytics in assisting with proactive population health management. In order to proactively manage patient outcomes, patient data must be presented to management in a meaningful way for analysis. The analyzed data should allow management and providers to make decisions and process changes positively impacting patient outcomes. These objectives raise the primary question: How can data analytics most effectively support proactive patient health management decisions?

This project presents a conceptual model organizations could follow to increase patient quality while transitioning to a value-based payment model. There are many changes within a healthcare organization to get to the point of efficiently using healthcare data to increase patient outcomes. Changes will most likely be unique within each organization and for this reason, a model may help guide the transition to value-based payment while integrating data analytics in a meaningful manner.

Problem Statement

Healthcare spending has grown continuously in the United States for the past several decades. According to the Centers for Medicare and Medicaid Services (CMS), health spending in 1960 was at \$27.4 billion, rising to \$921.5 billion in 1993. These increases represent an average rate of 11.2 percent annually (Klees, Wolfe, & Curtis, 2015). As depicted in figure 1, the Organization for Economic Cooperation and Development (OECD) in their Health at a

Glance 2015 report, the United States far exceeds health expenditure spending as a percentage of gross domestic product over any other country listed in the OECD report.



Note: Excluding investments unless otherwise stated.
 1. Data refers to 2012.
 2. Including investments.
 Source: OECD Health Statistics 2015, <http://dx.doi.org/10.1787/health-data-en>; WHO Global Health Expenditure Database.

Figure 1. Health expenditure as a share of GDP, 2013 (or nearest year)

Further, according to the CMS National Health Expenditure (NHE) 2014 historical data:

- NHE grew 5.3% to \$3.0 trillion in 2014, or \$9,523 per person, and accounted for 17.5% of Gross Domestic Product (GDP).
- Medicare spending grew 5.5% to \$618.7 billion in 2014, or 20% of total NHE.
- Medicaid spending grew 11.0% to \$495.8 billion in 2014, or 16% of total NHE.
- Private health insurance spending grew 4.4% to \$991.0 billion in 2014, or 33% of total NHE.
- Prescription drug spending increased 12.2% to \$297.7 billion in 2014, faster than the 2.4% growth in 2013. pg. 1

The federal government has passed several Acts in an attempt to get control of rising healthcare costs and declining healthcare value to patients. Changes to healthcare

reimbursement payments from these Acts are requiring healthcare facilities and professionals to transition from the current Medicare fee-for-service (FFS) payment model to a value-based payment model. The Health Information Technology for Economic and Clinical Health (HITECH) Act, which was passed as part of the American Recovery and Reinvestment Act, and the Patient Protection and Affordable Care Act (PPACA), began the movement to improve organizational outcomes through the use of Health Information Technology (HIT). To provide financial incentives to providers, the Medicare and Medicaid EHR Incentive Programs were created for the “meaningful use” of certified EHR technology to improve patient care. To receive an EHR incentive payment, providers have to show they are “meaningfully using” an EHR by meeting thresholds for a number of objectives. As a result of these Acts, most healthcare organizations implemented an Electronic Health Record (EHR) system to house patient data, allow for clinical physician order entry (CPOE), and the sharing of data among providers.

Need for the Project

The purpose of medical records is to provide a principal means of communication between healthcare professionals in matters relating to patient care. The medical record typically provides documentation of a patient’s illness, symptoms, diagnosis, and treatment while being accessed as a planning tool for patient care. The discrete data stored within the EHR medical records can be used to increase patient outcomes through utilization of data analytics and care management. Healthcare providers and management need to understand and integrate data analytics throughout their organization to make a successful transition to a value-based payment model. As healthcare facilities tackle improvement of the overall health of their patient populations, and enter payer risk-sharing payment models, they will be required to more actively

manage their associated patient population to prove increased patient outcomes (Eggbeer, Sears, & Homer, 2014).

Congress passed the Medicare Shared Savings Program (MSSP) to motivate providers to work together on managing and reducing unnecessary costs for their attributed Medicare FFS population. Eligible providers, hospitals, and suppliers may participate in the MSSP by creating or participating in an Accountable Care Organization (ACO). Within an ACO model, there is an increased need to apply data analytics and to analyze collected EHR data with data from multiple payers and providers to compare patient costs, and evaluate potential system over-utilization trends throughout the healthcare system (Nugent, 2010). The analysis of this data should be provided to management and ACO's in dashboards and reports to assist in making critical decisions toward increasing patient outcomes while decreasing over utilization. The goal of this project is to provide a conceptual model to assist management with the integration of data analytics, dashboards, and reports into their practices to increase population health management.

Overview of the Project

A literature review begins with a brief history of healthcare reform including an overview of current federal programs established by the government to reimburse healthcare providers. This is followed by a review of government programs that reward healthcare providers to transition to a value-based payment model transitioning them away from a FFS model. Additionally, methods of data analytics applied to healthcare and background information of current healthcare IT technologies for the manipulation and storage of patient data is reviewed as well as healthcare data available to organizations for the application of data analytics.

The application section defines the conceptual model and its application to improve patient outcomes through the implementation of data analytics. Data sources utilized for

healthcare analytics are defined along with suggestions for defining the population and their chronic conditions. With these defined populations, the model explains how organizations may apply their clinical knowledge to manage these chronically ill populations. The application section is followed by a discussion of the suggested implementation plan, evaluation of the implementation plan, limitations to this model, future research, and conclusions.

Literature Review

The major force within healthcare to move from a FFS payment system to a more value based program is being broadly initiated via the payer systems available throughout the United States today. This literature review begins with an overview of these payers systems, both public and private, as they work to impact population health by moving towards a more value based system.

United States Payer Systems

The different payer systems of the United States have each been created to provide lower cost, better quality, broader access, or some combination of these components. However, understanding the populations that each covers is not exactly straightforward. This section reviews Medicare, Medicaid, and private payer managed care plans, along with the access these payer systems provide and insight into their cost and quality.

Medicare. Medicare is a federal program that provides health insurance for people age 65 and older, people under age 65 with certain disabilities, and people with permanent kidney failure requiring dialysis or a kidney transplant. “CMS is the principal agency charged with administering Medicare, although other agencies within the Department of Health and Human Services (HHS), as well as in the Social Security Administration (SSA), play a role in Medicare administration” (Elliot, 2011, p. 1496). The Medicare program is made up of several programs

offering various benefits, including hospital insurance, medical insurance for doctors' services, and prescription drug coverage. “Medicare beneficiaries face a number of difficulties in acquiring and using information about their Medicare benefits, and most (60%) find choosing a health plan (e.g., a Medicare Advantage plan) to be a hard or very hard decision” (Morgan, Teal, Hasche, Petersen, Byrne, Paterniti, & Virnig, 2008, p. 2053).

Medicare – Part A. Medicare Part A, also known as the hospital insurance program, helps cover the costs of inpatient care in hospitals or skilled nursing facilities, hospice care services, and some home health care services. This portion of Medicare is funded through Social Security payroll taxes. If a person is eligible for Medicare, they will not have to pay a monthly premium for Part A, as long as they or their spouse paid Medicare payroll taxes while working. If they did not work, or did not pay enough Medicare payroll taxes, they may not be eligible for premium-free Part A. However, they may be able to purchase Part A by paying a monthly premium (Klees, Wolfe, & Curtis, 2015).

Medicare – Part B. Medicare Part B, also known as the medical insurance program, helps pay for Doctors’ services, outpatient care, some services not covered under Part A (some home health services, physical therapy, and occupational therapy), and some preventive services. Most people pay a standard monthly premium for Part B, but it can vary based on your income (Klees et al., 2015).

Medicare – Part C – The Medicare Advantage Program. Medicare Part C, also known as the Medicare Advantage program, allows individuals to choose a health plan offered by a private insurance company that is approved by Medicare (Klees et al., 2015). Medicare Advantage plans include managed care organizations and private fee-for-service (PFFS) plans.

Medicare Advantage plans receive payments from Medicare to provide beneficiaries with

the benefits covered by Medicare, including Part A (hospital) and Part B (physician and outpatient services). Most Medicare Advantage plans also include Part D coverage (prescription drug benefits), and many offer extra coverage such as vision and hearing care, dental services, and health and wellness programs. In addition to a Part B monthly premium, Medical Advantage plans can also charge an additional monthly premium and copayments for some services.

Medicare – Part D. Medicare Part D, an outpatient prescription drug benefit, is offered to everyone with Medicare. To get Part D drug coverage, beneficiaries have to join a plan run by a private insurance company that has been approved by Medicare or enroll in a Medicare Advantage plan that includes drug coverage. Part D prescription plans are offered on a state-by-state basis and most states have 40 or more plans available. Although all these plans must offer at least a standard drug benefit determined by Medicare, they may provide additional benefits.

Medicaid. Medicaid provides access to health care for 58 million low-income Americans, and with the implementation of the Patient Protection Affordable Care Act (PPACA), up to 11 million more people were able to enroll in Medicaid beginning in 2014. The federal government establishes general guidance for Medicaid, but state governments create their own specific requirements in addition to federal guidelines. Medicaid provides health insurance for low-income families with children, long-term care for the disabled and older Americans, and supplemental coverage for low-income Medicare beneficiaries for services not provided by Medicare (Klees et al., 2015). “Over its 46-year history, Medicaid has become the nation’s health care safety net, serving as a buffer to the perils of an uncertain economy by providing access to health services for those who cannot afford private insurance” (Medicaid Provider Assessments, 2011, p. 2).

Unlike Medicare, which reimburses providers through intermediaries such as Blue Cross, Medicaid directly reimburses service providers, neither Medicare nor Medicaid is a comprehensive program with each requiring their beneficiaries to share in some of the costs. According to the American Hospital Association (2012), on average, Medicaid only covers 89 cents of every dollar spent treating Medicaid patients. According to Medicaid.gov, in 2014, approximately 80% of Medicaid beneficiaries were enrolled in managed care plans. The enrollment in managed care plans is due to states trying to contain costs while continuing to provide access to health care to low-income and underserved populations.

Private payers - Managed care plans. There are a wide variety of managed care models that integrate financing and management with the delivery of health care services to an enrolled population. Today, managed care is equivalent to health insurance, and according to Sultz & Young (2009), "...employers provide the primary source of health insurance, covering approximately 159 million Americans under age 65 years" (p. 235). Health maintenance organizations (HMOs) and preferred provider organizations (PPOs) are two models that are most common for managed care plans.

Health Maintenance Organization. In 1973, the Health Maintenance Organization Act supported the creation of HMOs, which are organized health care systems responsible for the financing and delivery of a broad range of comprehensive health services to an enrolled population. "HMOs were expected to hold down costs by changing the profit incentive from fee-for-service to promoting health and preventing illness" (Sultz & Young, 2009, p. 41).

Individuals participating in a HMO obtain most or all health care from a network provider. As part of an HMO, they must select a primary care physician (PCP) who is in charge of supervising and organizing all their health care needs and, a personal physician to deliver

primary healthcare services. PCPs include internal medicine physicians, family physicians, and in some HMOs, gynecologists who provide basic healthcare for women. In the case of young children a pediatrician or a family physician can be selected as a PCP.

In an HMO, access to care is typically limited to in-network services and physicians. Referrals are needed from the PCP in order to see an in-network specialist or to receive further diagnostic services such as x-rays or lab work. If they do not have a referral, or choose to go to a physician outside of the HMO's network, they generally have to pay all or most of the cost for that care.

Preferred Provider Organization. A PPO is a health plan that has contracts with a network of "preferred" providers from which the plan recipient can choose. Unlike an HMO, there is not a requirement to have a PCP, and referrals are not needed to see other in-network providers. Care received from doctors within the preferred network only requires a copayment for the visit and payment of the annual deductible. While out-of-network doctors can administer health services, payments are generally made directly to the doctor by the patient and claims have to be filed in order to receive reimbursement. "Currently, PPOs are the most popular managed care plans, encompassing 60% of employer-covered workers" (Sultz & Young, 2009, p. 236).

Summary - Payer Systems

Each of the payer systems just described helps a particular set of the population gain access to some level of health care. Medicare and Medicaid increase access to the United States aging and low-income populations, while HMOs and PPOs cover the majority of Americans under age 65. Although managed care is not just for those under age 65, Americans in either Medicare or Medicaid may also receive their coverage from an HMO or PPO.

Lastly, quality and cost remain a major concern with all of the payer systems. Evidence shows that the quality of health care provided has slipped while health care costs have continued to increase (Futrell, 2013; Ward, Marsolo, & Froehle, 2014). For these reasons, health care reform is needed and will add to changes in not only Medicare and Medicaid, but also to the structure of managed care organizations. As stated by Sultz and Young (2009):

President Johnson's ambitious activation of the concept of creative federalism enriched the country's health care system and improved the access of many impoverished citizens to continually improving medical care, but it also fueled the inflationary spiral of health care costs that has yet to be constrained. (p. 41)

Due to these spiraling healthcare costs, the federal government took action in 2009 setting in motion what we now refer to as healthcare reform.

Healthcare Reform

As stated in Meaningful Use Stage 1 Final Rule (2010), from here on referred to as the Final Rule:

The American Recovery and Reinvestment Act of 2009 (ARRA) (Pub. L. 111-5) was enacted on February 17, 2009. Title IV of Division B of ARRA amends Titles XVIII and XIX of the Social Security Act (the Act) by establishing incentive payments to eligible professionals (EPs), eligible hospitals, and critical access hospitals (CAHs), and Medicare Advantage Organizations to promote the adoption and meaningful use of interoperable health information technology (HIT) and qualified electronic health records (EHRs).

These provisions, together with Title XIII of Division A of ARRA, may be cited as the "Health Information Technology for Economic and Clinical Health Act" or the "HITECH Act." These incentive payments are part of a broader effort under the HITECH Act to

accelerate the adoption of HIT and utilization of qualified EHRs. (p. 13)

Within this Final Rule it simply states where HITECH comes from, and what its impact is to health care organizations. The HITECH act was born out of the ARRA.

American Recovery and Reinvestment Act of 2009. As stated in the Final Rule, ARRA was enacted on Feb. 17, 2009. This happened at the urging of President Obama as a direct response to the economic crisis, and the Recovery Act had three immediate goals: create new jobs while saving existing ones, spur economic activity while investing in long-term growth, and foster unprecedented levels of accountability and transparency in government spending. According to the Congressional Budget Office (CBO), the Recovery Act intended to achieve these goals by providing \$787 billion in tax cuts and benefits to millions of working families and businesses coupled with the funding of programs such as unemployment benefits and the creation of federal contracts, grants, and loans. Additionally, as part of the funds appropriated under the Recovery Act, approximately \$44 billion for incentive payments were earmarked to further advance the adoption of HIT and the qualification of EHRs.

According to the Medicare and Medicaid Services Electronic Health Records Program payment and registration data March 2016 report forms, \$33.6 billion has been paid out since the Medicare and Medicaid EHR incentive payment programs began making payments in 2011. These payments include, \$20 billion to 13,107 hospitals, \$13.2 billion to 495,698 unique physicians and other eligible professionals mostly working in ambulatory care, and the remaining \$450.9 million paid to 14,845 EPs in a few Medicare Advantage programs.

Health Information Technology for Economic and Clinical Health Act. Simply stated, from the Final Rule, HITECH is a combination of two Titles under the ARRA, Title XIII of Division A and Title IV of Division B. Title XIII further defines the national implementation

of HIT and Title IV provides clarification to the incentive payments established as part of the HITECH Act.

Title XIII – Health Information Technology. Under this Title the Office of the National Coordinator (ONC) for HIT and the HIT Policy Committee were established within the Office of the Secretary for the U.S. Department of Health and Human Services (HHS). “ONC is the principal federal entity charged with coordination of nationwide efforts to implement and use the most advanced health information technology and the electronic exchange of health information” (Health IT, para 2). Critical to the implementation of meaningful use, Title XIII also establishes the requirement for the ONC to be the certifying body for Certified EHR Technology (CEHRT). In order for health care providers to receive incentive payments from CMS, they must first adopt CEHRT and prove they are meaningfully using it.

Title IV of Division B – Medicare and Medicaid Health Information Technology. As stated in the Final Rule, Title IV amends the Social Security Act by establishing incentive payments to EPs, eligible hospitals, CAHs, and Medicare Advantage Organizations to promote the adoption and meaningful use of interoperable HIT and qualified EHRs. The main purpose of this Title is to establish the entities that can receive incentive payments and what they must do to qualify for them. CMS is the government entity that qualifies EPs and healthcare organizations for meaningful use through their attestation process. Once qualified, in order to receive incentive payments from CMS the EP, eligible hospital, or CAH must continue to comply with meaningful use requirements for the stage they are currently in.

Health Insurance Portability and Accountability Act of 1996. Health Insurance Portability and Accountability Act (HIPAA) is also important to HITECH, as it is mentioned several times within the Act itself. The importance of HIPAA to HITECH stems from the

confidential patient information that is mandated to be stored in EHRs and transmitted via broadband lines to increase Health Information Exchange (HIE). Patient data has to be secure not only for each patient's personal reasons, but also because the Security Rule under the HIPAA regulations mandates the protection of certain patient data being stored or transferred in electronic form. Healthcare organizations, also referred to as covered entities under HIPAA, are responsible for patient data. These covered entities must follow voluntary compliance rules and are subject to civil monetary penalties if compliance is not met or in the event of a data breach of electronic protected health information (ePHI).

The new HIPAA security paradigm within HITECH demands much greater awareness of the location of ePHI, where it is going, who is touching it, what they are doing with it, and much more effective controls to meet the requirements of access, limited minimum data, accounting for disclosure, and breach notification. "Although HITECH did not demonstrably change the HIPAA security rule, it has clarified the rule's specifications and has increased the risks associated with noncompliance" (McMillan, 2011, p.124).

Meaningful Use. The Medicare and Medicaid EHR Incentive Programs provide financial incentives for the "meaningful use" of certified EHR technology and interoperable health information technology to improve patient care. To receive an EHR incentive payment, providers have to show they are "meaningfully using" EHRs by meeting thresholds for a number of objectives (Futrell, 2013). CMS has established the objectives for "meaningful use" that eligible professionals, eligible hospitals, CAHs, and Medicare Advantage Organizations must meet in order to receive an incentive payment. There are three stages laid out by CMS a provider must follow in order to attain meaningful use and comply with federal regulations enacted by the HITECH act.

Beginning in 2011, the Medicare and Medicaid EHR Incentive Programs were staged in three steps with increasing requirements for participation. All providers were able to begin participating by meeting the Stage 1 requirements for a 90-day period in their first year of meaningful use and a full year in their second year of meaningful use. After meeting the Stage 1 requirements, providers then had to meet Stage 2 requirements for two full years. Most years since the inception of the EHR Incentive programs, the criteria for meeting the stages has come under scrutiny and been revised for the following year. According to the CMS EHR Incentive Program, the only stages of meaningful use left to attest to are Modified Stage 2 for 2016 or 2017 and Stage 3 for 2017 and beyond. Eligible professionals participate in the program on the calendar years, while eligible hospitals and CAHs participate according to the federal fiscal year.

Reporting on clinical quality measures. In Stage 1 of meaningful use for the Medicare and Medicaid EHR Incentive programs, clinical quality measures (CQMs) were required as a core meaningful use objective. EPs, EHs and CAHs who wish to participate in the EHR Incentive Program must submit data from certified EHR Technology CQMs in order to receive an incentive payment in the EHR Incentive Program. CMS does state that in Modified Stage 2, CQMs are no longer a core meaningful use objective; however, EPs, eligible hospitals, and CAHs are still required to submit CQMs in order to successfully participate in the program. So, even though CQMs are no longer required, they are required if recipients want to continue to receive incentive payments. The CQMs, required by future stages of meaningful use, will need coded data elements in order to facilitate the ability to study specific data about patient conditions and treatments (Futrell, 2013).

Medicare quality programs. Value-based programs reward health care providers by providing incentive payments for the quality of care they provide to the Medicare population.

These programs are part of a larger quality strategy to reform how health care is delivered and paid for. One of the main drivers behind CMS's move to add the value based programs is the alignment with the triple aim. The triple aim is focused on improving the quality of healthcare provided to patients, reducing the costs of healthcare, and increasing access to healthcare (Jackson, 2014). CMS states, in the Medicare Access and CHIP Reauthorization Act of (2015) (MACRA) proposed rule, it "...is focused on three core strategies to drive continued progress and improvement" (p. 19). These include the following:

1. Focusing on improving the way clinicians are paid to incentivize quality and value of care over simply quantity of services.
2. Improving the way care is delivered by providing clinical practice support, data and feedback reports to guide improvement and better decision-making.
3. Making data more available to healthcare organizations while enabling the use of certified EHR technology to support care delivery.

Figure 2, retrieved from CMS.gov, gives a timeline depiction of legislation passed and the Medicare value-based programs resulting from legislation when they were or will be implemented.

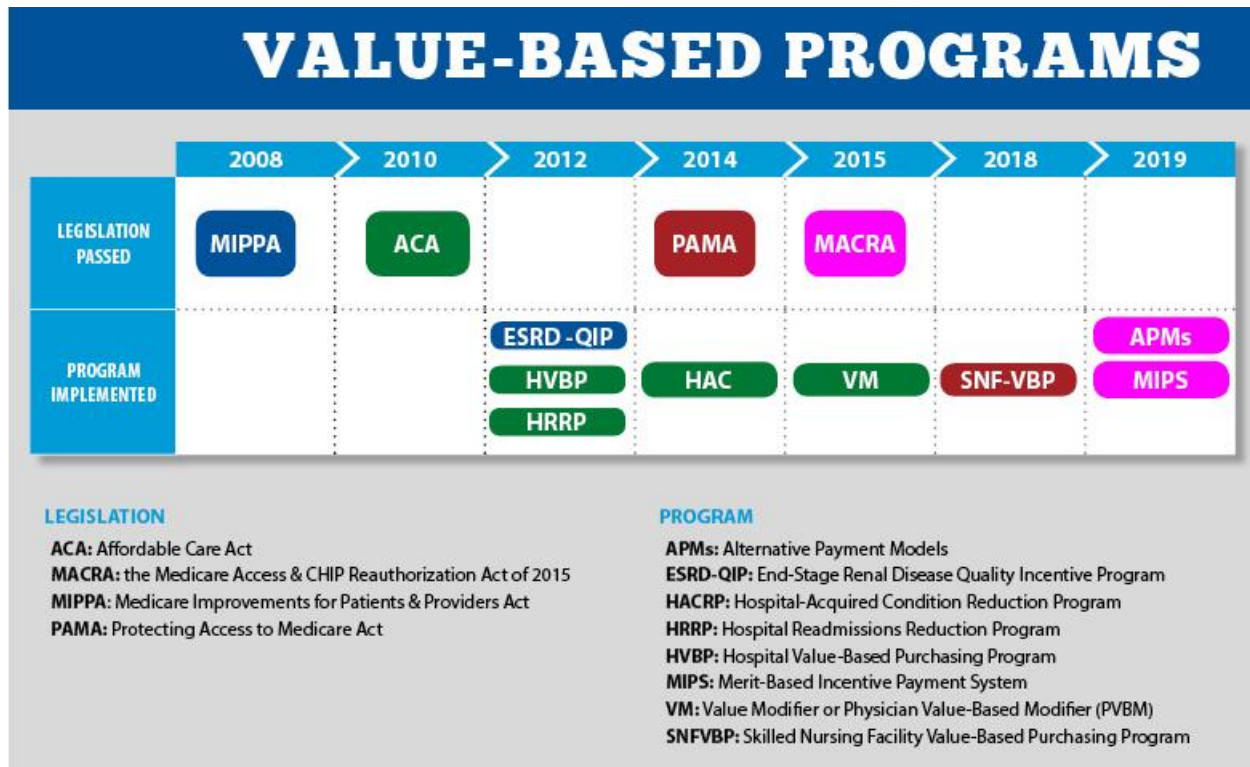


Figure 2. Medicare value-based programs and legislation, depicted on a timeline.

While information is provided on some of the latest Medicare programs, detailed information on any programs listed above can be found on the CMS.gov website. All of the above listed programs, either provide incentive payments for achieving the goals of the program, or apply negative adjustments to the anticipated Medicare reimbursements for non-compliance.

Medicare Access and CHIP Reauthorization Act. MACRA authorized CMS to implement the Merit-Based Incentive Payment System (MIPS) and Alternative Payment Model (APM) programs. Organizations can start to implement the suggested MACRA changes starting in 2018. The new programs, collectively referred to by CMS as the Quality Payment Program, establish new ways to calculate payments to providers. As stated by CMS, the goal of these programs is to continue to support healthcare quality, efficiency, and patient safety.

MACRA reforms the long-time sustainable growth rate (SGR) formula dictating the way physicians and other clinicians are paid and replacing it with a new system rewarding value and outcomes. Additionally, the law consolidates the current meaningful use, Physician Quality Reporting System (PQRS), and Value-based Payment Modifier programs, aligning them and retaining components of each as a part of the newly proposed system. Figure 3, retrieved from CMS.gov, is a representation of how these programs come together along with the suggested adjustments for payment.

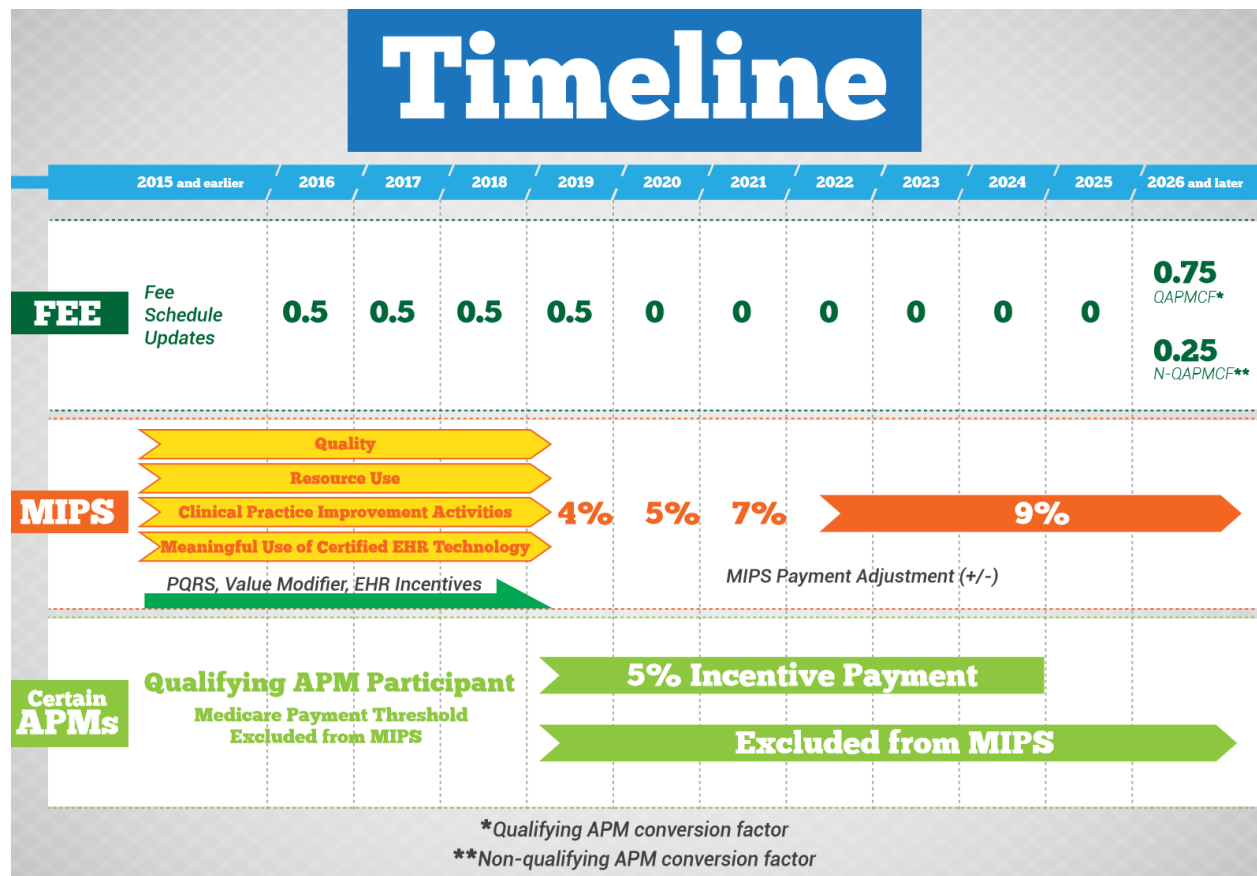


Figure 3. Value-based program timeline depicting suggested implementation dates for MACRA.

Healthcare Data Analytics

As healthcare organizations transition from volume to value, population health management requires analytic views across the population of patients that combines clinical and



claims data (Finberg, 2012; Jackson, 2014). Historically, medical records primary use was to monitor the treatment of individual patients and claims data in order to manage insurance costs; however, the latency of claims data and limited availability of patient clinical records from healthcare organizations restricted the timely value of population health management solutions. “The adoption of EHRs and other electronic mechanisms makes the application of analytic tools more tractable by providing the basic electronic data upon which to act” (Ward, Marsolo, & Froehle, 2014, p. 574).

Data sources. Source data for healthcare analytics typically comes from two categories of electronic health information. Either the data has been collected during the patient billing and claims submission process, or it is clinical data that has been collected as part of a patient encounter and entered into the EHR or stored on other internal healthcare systems such as lab systems (Futrell, 2013).

Claims Data. Claims-based data from health plans, both private and governmental, has been collected for years and can supplement EHR data. Every claim submitted for reimbursement from a healthcare organization is coded with standardized codes describing the procedures, labs, and orders performed during a patient encounter (Futrell, 2013; Ward et al., 2014). One of the more common coding processes and the current standard is the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) code set. ICD-10 is classified by the World Health Organization (WHO) for the “coding of diseases, signs and symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases” (Medicaid.gov, para 1). While EHR data tells a comprehensive story of the interactions a patient receives within a healthcare organization, claims data tells a more complete story of a patient’s interactions with all healthcare facilities.

Claims data provides an essential structured data set used in the process of associating risk to patients. The risk associated to a patient increases with the chronic conditions associated to the patient during healthcare interactions (Hannah & Hancock, 2014). Once assessed by a provider, patient's chronic conditions are first captured in the EHR, then coded and submitted to payers via electronic data interchange (EDI). The purpose of EDI is to reduce the use of paper in the claims submission process by replacing it with a computer-to-computer exchange of standardized electronic information. With provider risk-sharing contracts there is significant advantage to healthcare providers to thoroughly capture patient diagnosis data (Hannah & Hancock, 2014). Risk-sharing agreements are geared towards moving both providers and health plans away from FFS and towards more value based payments by rewarding them for managing high risk patients appropriately (Nugent, 2010). While claims data provides essential data to flag patients for care management, the data residing within the EHR is more specific and provides another level of specificity in the inquiry of the data via data analytics (Wills, 2014).

Clinical data. Historically, the documentation of clinical encounters taught the healthcare industry to record data in the most convenient way for the provider. These provider-centric workflows left little regard for how clinical data could someday be aggregated and analyzed to increase patient outcomes. EHRs aim to systematize the data capture process, but providers are often resistant to adopt a singular prescriptive approach to clinical workflows and documentation (Wills, 2014). Often, the recording of unstructured data is tolerated to satisfy discouraged EHR users and avoid delaying the process of care delivery. As a result, much of the data captured via this manner is difficult to aggregate and analyze in any predictable manner. As EHR products improve, and users become trained on standard workflows, and, as care providers

become more accustomed to entering data into structured fields, access will increase to a greater quantity of clinical data with better quality for analytics.

Clinical data can come from many sources such as picture archive and communications systems (PACS), laboratory information management systems (LIMS), pharmacy systems, and many other diagnostic monitoring devices including patient input devices like Fitbits (Ward et al., 2014). It is becoming more common for this data to be incorporated directly into the EHR. With all of these data sources, prep work needs to be done to aggregate the data into a usable manner for storage and ultimately utilization via data analytics.

Data warehouse. EHR data, claims data, and any other data available and pertinent to the cost or care of a patient, ultimately needs to be loaded into a data warehouse through a process known as extract-transform-load (ETL) (Chang, Nielsen, & Macias, 2013; Ghosh & Scott, 2011). The extraction process takes the data from the current source database, then via an interface engine the data is transformed and inserted or loaded into the appropriate form within the data warehouse databases (Ghosh, & Scott, 2011). Although the task of extracting data from EHR software can be quite daunting, most systems typically support Health Level Seven (HL7) messaging to allow the data to be sent directly to an HL7 interface engine (Ward et al., 2014).

HL7 is a standard that has been around since 1987 to bring a common transport method for electronic health information, not only to EHR's, but to all clinical software and devices (Ghosh, & Scott, 2011). To help shape the future of interoperability, a new framework is under development and currently being trialed called Fast Healthcare Interoperability Resources (FHIR). FHIR's goal is to use existing resources to "solve real world clinical and administrative problems at a fraction of the price of existing alternatives" (HL7.org, para 2). If FHIR is

successful in accomplishing this lofty goal, the task of extracting clinical data will become much more uniform and less daunting than it is today.

Data analysis. Once the data has been loaded into the data warehouse, business intelligence (BI) can be applied to data analytic engines to query the data and formulate meaningful insights with the data (Ghosh, & Scott, 2011; Hannah, & Hancock, 2014). The goal of applying analytics to healthcare data is to transform the data into usable information and allowing it to be relayed back to end users (Ward et al., 2014; Wills, 2014).

Predictive analytics. Predictive analytics is the application of predictive algorithms to the compiled data set within the data warehouse for forecasting outcomes of risk, costs, and trends associated to patients or care provided to patients. Clinical analysts build the algorithms into the predictive analytics software packages allowing care managers and healthcare providers to easily build and run reports for defining patient populations (Bradley & Kaplan, 2010). The real value in predictive analytics is the ability to use it to dig into data revealing trends not apparent on the surface of the data (Bradley, 2012). In managing patient populations, one common example of the use of predictive analytics would be to forecast for patients most likely to be readmitted to the hospital. In this example, a pursuit list report could be generated to begin management of the population at risk of readmission (Bradley, 2012).

Real-time analytics. The ultimate goal in applying analytics to healthcare is to receive information in real time assisting caregivers with care support decisions. Real-time analytics uses information as soon as it enters a data source to start formulating suggestions. It couples information from all sources it is linked to, such as disease registries, along with the data captured among all integrated sources to provide decision support to providers with suggestions

on diagnoses and treatment (Wills, 2014). Due to the large expense and training costs associated with real-time analytics, its adoption into healthcare has been slow.

Reporting. Analytics software provides insightful data in the form of reports and dashboards, allowing caregivers to take action on the results of the data analysis performed with BI and analytics. The software can be programmed to send reports directly to users of a specific group or department. It is also common for dashboards to be built and customized displaying important information to the individual user currently viewing the information within the software (Bhattacharya, Ramachandran, & Jha, 2012; Ward et al., 2014). Inside a dynamic dashboard, users can drill down into information to get more specific data. For instance, on the readmission example used earlier, the data could first be displayed as a chart showing percentages of groups of chronic condition patients at risk for readmission within 30 days. A user could then click on the chart section associated to chronic heart failure patients to see a list of the population ordered by highest risk for readmission. These self-service BI features of data analytics very quickly turn a chart into actionable data for caregivers.

Care Management

It takes a team to manage a population's health. Care management is an essential part of the population health management team, intended to improve patient care and reduce the need for medical services through helping patients and caregivers more effectively manage health conditions (Handmaker & Hart, 2015). The reports and dashboards created via data analytics are an essential tool to this team along with the ability to use the self-service BI features of data analytics to further investigate patterns in affected populations.

The role of the care teams is to use the output of data analytics to make decisions for the affected population (Esperanza Lopez, Carberry, & Macias, 2015; Handmaker & Hart, 2015).

They need to apply their clinical knowledge or BI and ask questions of the data they have received from the analysis (Hannah & Hancock, 2014). As the care team further refines the data into manageable pieces to take action upon they can develop care management plans and clinical best practice workflows to impact the care of the population defined (Esperanza Lopez et al., 2015). This is the application of a scientific approach to healthcare. Use the data to develop a clinical hypothesis, create a plan, take action, review the results, and adjust accordingly (Jackson, 2014). It is important to revisit reports and setup a monitoring plan to manage the impact of changes made to the care plan. Additionally, seeing the results of the care management approach can take time before the implemented workflows show their impact via changes in the analytic reports.

ACO care teams. One of the benefits of ACO participation healthcare organizations is often the free access to predeveloped reports and care management programs designed by the ACO. ACO participants are able to share in the savings attributed to them and redistributed through the MSSP (Nugent, 2010). This essentially broadens the care teams focused approach to a much larger population and becomes more economical through the sharing of resources. This sharing of resources allows teams to develop a healthcare systems approach, allowing the care to direct and follow the patient to the appropriate resources within the systems (Finberg, 2012). This is where hospitals and clinics begin to work together better on reducing readmissions by combing their compiled data sets, adding value by reducing costs of hospital readmissions and over utilization of medical resources (Landman, 2013).

Whether teams are focused on care management of their organization's population or a larger ACO population, there is a need for a model to guide the implementation and use of

applying data analytics to population health management. In the application section a potential model for organizations to follow is presented.

Application

The literature supports the conceptual model displayed in figure 4. The model depicts how healthcare management can use data analytics to assist with proactive population health management. In order to proactively manage patient outcomes, patient data must be presented to management in a meaningful way for analysis. The analyzed data will allow management and providers to make decisions and process changes in order to positively impact patient outcomes. It is the objective of the population health management conceptual model to assist organizations in increasing patient quality while transitioning to a value-based payment model. An overview of each step of the model is presented along with how it impacts the steps to come.

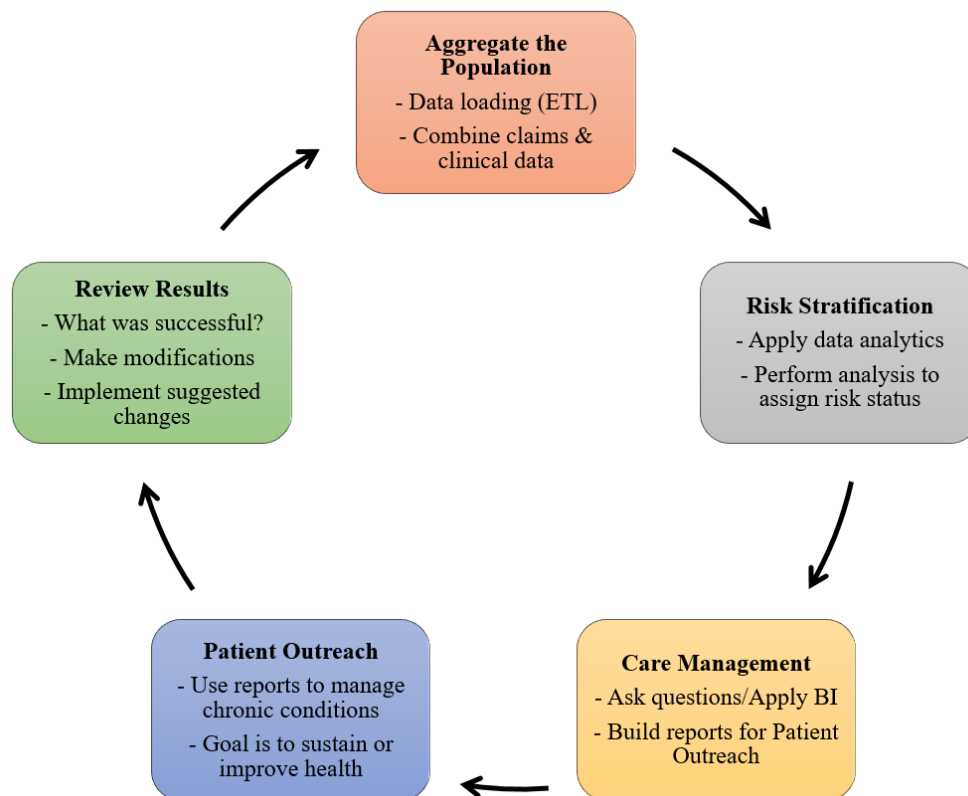


Figure 4. Population Health Management Conceptual Model.

Aggregate the Population

Aggregating the population is the starting point of this model; aggregation refers to the coming together of the population's data elements into one central location, the data warehouse. The data is unified into the data warehouse from the disparate claims and clinical data sources available to the healthcare organization. In this model, ETL processes are constantly populating data into the data warehouse as it is made available. Claims data alone identifies only about 80% of the target population and omits critical diagnosis information. Claims data combined with clinical data provides a more holistic view of the at-risk population. The aggregated data set allows advanced data analytics to identify populations of at-risk patients for further segmentation and analysis by risk, utilization, and cost.

Risk Stratification

According to the American Academy of Family Physicians (AAFP, 2016), "...risk-stratified care management (RSCM) is the process of assigning a health risk status to a patient, and using the patient's risk status to direct and improve care" (AAFP.org, para 1). In order to stratify the aggregate data set of population by associated risks, data analytics will need to apply logic to the data. This is where care teams need to start asking questions of the data in order to segment patients in need of intervention from patients whose chronic conditions are well-managed. Predictive analytic algorithms can be applied to intercept patient's at-risks for high cost complications and care before an actual occurrence or episode.

Because both the clinical and claims data are available for consumption by the analytic processes, other answers can be stratified from the data as well. Care teams can apply additional logic to look for patients with high utilization or cost patterns of care services and physicians with inefficient practice behaviors or poor outcomes of care. This presents care teams with

actionable data via reports and dashboards to begin the process of planning the next course of action.

Care Management

Armed with actionable data, care teams need to make critical decisions on how to act on the data they are presented with to assure efficient use of their resources and provide better clinical outcomes. Some decisions and courses of action will be easy. For instance, data may show that diabetic patients are not being scheduled for regular follow-up visits that are contributing to their chronic condition not being properly managed. This can simply be resolved by taking the resultant set of diabetic patient data to patient outreach to get return appointments scheduled for these patients. This should allow the patients to be properly managed and reduce the risks of this subset of patients.

Within proper care management, the care team needs to apply clinical BI analysis to the data seeking answers to difficult questions such as:

- Why weren't the diabetic patients scheduled for return visits?
- What processes can be put in place to ensure patients are being appropriately managed?
- What additional data is required to further investigate this issue?
- Is there something unique about this subset of patients?

Having answers to their questions will allow the team to make educated decisions impacting the outcome of patients care. This type of data analysis is at the core of making data analytics work to improve population health. In order to significantly impact care, data needs to be used to modify existing programs and services, or create new programs to change how care is currently being administered. Care management, and the actions the care team takes, may use data

analytics to guide their decisions, but ultimately their decisions are made based on their clinical knowledge and industry best practices for managing patient populations.

Patient Outreach

Patient outreach is the result of more closely managing patient care via population health management. The focus on outreach within this model is more about managing patient care to increase the quality of outcomes and reduce the costs of more costly readmissions. It is about maintaining and increasing the health of the population versus just reacting to it once a patient presents with a chronic condition. By reaching out to patients and appropriately managing their care, it is the purpose of this model to aid in the prevention of chronic disease by closing current gaps in care.

Review Results

Once the care team has taken action by reaching out to patients to better manage their care, they need to consistently reevaluate to see if their actions are having the intended impact. Analytics should be applied to the aggregated data set to determine intervention and outreach effectiveness. Use a scientific approach to determine which interventions make the biggest difference in the high-risk population. When looking at high-risk chronic conditions, determine if the percentage of patients meeting the criteria for each measure has increased or decreased. Additionally, when looking at the data for patients, providers, and services, it is important to determine if cost and utilization have been reduced from previous levels. It will be important to trend data and document changes made so the team can review those changes that were effective in reducing risk, cost, or over-utilization.

This model is a cycle that is ongoing. Once an organization is armed with new found data from previous attempts at managing the population, the care team can adjust accordingly

and try again. The cycle is a continuous flow of aggregating data, applying analytics to stratify risks, taking action through care management coupled with patient outreach, and reviewing results. More details on the implementation of the population health management model are presented in the Discussion section.

Discussion

This project presented a conceptual model healthcare organizations could follow to increase patient quality while transitioning to a value-based payment model. There are many changes within a healthcare organization to efficiently use healthcare data to increase patient outcomes. Changes will most likely be unique within each organization, and for this reason, the population health management model presented can help guide the transition to value-based payment, while also integrating data analytics in a meaningful manner. Suggestions for implementing the model are provided, along with further discussion regarding evaluation of the implementation plan, limitations to this model, future research, and conclusions.

Implementation

The purpose of the model presented is to assist management in a care team's use of data analytics to successfully manage the health of their patient population. Once an organization has decided to proactively manage the health of their patients, the first step is to establish a care team responsible for implementation of the population health strategy.

Care team. “In an organization seeking to manage population health, care managers are part of collaborative teams that include patients' primary care physicians, specialists, nurses, medical assistants, and ancillary providers (e.g., pharmacists and physical therapists)” (Handmaker & Hart, 2015, p. 75). The care team should consist of staff who are knowledgeable about the care and management of chronic conditions. This is important, because the sole

purpose of population health management is to properly identify and manage patients with chronic conditions. Training will be required for the care team on risk stratification and how to apply it to a population. When the team understands how to stratify the population in order to appropriately assign risk, they will be better prepared to know what to ask of a data analytics system.

Data analytics. The next step in the process is picking a data analytics system to implement. Most likely, the data analytics system will come with its own data warehouse, and services for installation will be available for purchase from the chosen vendor. Before the team can decide on a data analytics system, they will need to decide what data they are anticipating to receive from the system, in order to help stratify the risks of the managed patient population. This will help the vendor selection process to ensure the chosen candidate's data analytics system can provide the needed reports and dashboards required for risk stratification, care management, patient outreach, and reviewing of results.

With a chosen vendor and system, management will need to decide how much of the system they want to implement and support with internal information technology (IT) staff, rather than augmenting with vendor supported services. The IT team and analytics vendor can then begin the project of implementing the data warehouse and associated data analytics software. The care team is essential to ensuring the success of the software implementation. They are needed to help define the data sources aggregated into the data warehouse, along with the appropriate structured data extracted from those sources. If the proper input data is not defined when configuring the ETL processes for data aggregation, it will be impossible to get the expected risk stratification reports in future steps of the model. With the software installed, and

the appropriate data aggregated, the care team can begin the process of using the information collected to take action.

Risk stratification. To begin the risk stratification process, the care team will need to segment the patient population by patients sharing common attributes, as a first attempt to look at chronic condition trends. The predictive analytics should help to define groups of patients into actionable lists of at-risk patients for further segmentation and analysis by risk, utilization, and cost. Risk stratification is an ongoing process, and the care team will continue to come back to this process as they further define the population, and drill down into the data for answers. The care team can use this data to build dashboards and reports that would be useful by care management in the development of programs to better manage the at-risk population.

Care management. With the patient population defined and risk stratified, the team must use their clinical knowledge to develop workflows and processes to manage the population. They will use the reports and dashboards created in previous processes to help guide their focus in developing clinical processes for increasing patient outcomes. The amount of data available for data analysis will most likely be overwhelming, so it will be important for a care team to first focus on one obvious chronic condition that needs to be managed. The team should take note of what the data is portraying about this chronic condition, and use this data to assist in the care management program development. This requires using the data to develop patient-centered care plans and interventions with patient outreach to coordinate care for the care team.

Once a chronic condition care management program has been developed, the team will need a strategy for dissemination throughout the healthcare organization. The EHR software may need to be configured to support new workflows that nursing staff and providers will need to utilize for the program. For this reason, it will be important to have a training plan in place to

educate the organizational care teams on the programs needed, workflows, and their importance to the management of the defined chronic condition. There is the potential for resistance as the workload to nursing staff and providers is increased to support the care management program. For this reason, it will be important to have administrative support to ensure all care teams implement defined programs consistently.

Patient outreach. When the healthcare care teams are ready to support the new program, patient outreach will provide a pursuit list of patients to schedule for appointments. It will also be important to ensure there is access available within the system to care for the additional patients. Patients should be included in care planning as a method of ensuring to incorporate their goals into the care plan and objectives. As patients are brought in and cared for through the program, the data will continue to populate the aggregated data set for further data analysis by the care team. This allows the team to measure the effectiveness of the designed program for increasing patient outcomes.

Review results. The key to continued effectiveness of the population health program is the ongoing evaluation and improvement of the programs. It is important to review results via reports performed on the aggregated data set to assess if the goals of the program have been met. Even when the goals of the program are not met, it will be important to learn from what was implemented successfully in order to fully synthesize the results of the program. When the results are understood by the care team, program modifications should be implemented to adjust accordingly. These findings can then be applied to other chronic conditions that may benefit from a similar care management program. At this point, the model is fully implemented, and the population health management cycle should continue to use data analytics to improve the health of the patient population.

Measuring Success of the Model

This model focuses on measuring success, and built into its design is the ability to measure the effectiveness of the process. An organization will know it is successful in implementing this model if it has achieved the ability to successfully utilize the implemented data analytics program to measure the health of their patient population. Analytics allows the organization to not only stratify the patient population, but also to measure the success of the programs. It is important for the care team and management to have patience as it will take time for the results to show measurable improvement in the population.

Effectiveness of this model is shown through the ability of the organization to use it to achieve better health outcomes, less over-utilization, and reduced costs. Because each of these can have different measurement metrics, to prove success of the program, it will be important to set a baseline for measurement before the program begins. This way, teams can return to the baseline to measure effectiveness of the program as compared to current results and outcome metrics.

Limitations

Implementing this population health model to proactively manage patients with data analytics has some limitations. The major concerns for implementation are the technology, access to the appropriate data required for analysis, and the care teams need to implement the required changes.

Technological issues. The software required for data analytics imposes some limitations upon it. Most importantly, is the applications ease of use by the care team. If the data analytics program is not easy to access and simple to retrieve data from, in a meaningful manner, the staff will refuse to use it or will not be able to achieve the required results. Additionally, the IT

platform running the data warehouse and data analytics must be stable. Again, if staff are unable to retrieve data, they cannot impact patient care. This is a limitation to not only the data analytics system, but all electronic means of capturing data.

Data issues. In order to expect successful results, proper input data needs to be defined during the data aggregation process to get the expected risk stratification reports as output from the data analytics. Access to the appropriate data for data aggregation can be an issue at times for several reasons:

- There is a lack of qualified standards for sharing data among systems.
- In clinical data, often times the data being searched for is contained within unstructured data, yielding it unusable for data extraction.
- Gaining access to claims data can create issues due to the competitive concerns of sharing data between competing healthcare facilities.

Most of the time, issues with access to data can be overcome, but it adds cost to the project and time to the overall implementation.

Care workflows. Often, providers and nursing staff are resistant to the additional workload created by implementing population health workflows. Many health care professionals have been trained that the more patients they saw, the more money they made for the organization, so these new workflows that take more time are counter-intuitive to them. The new workflows, however, are needed in the shift to improve the quality of care provided and ultimately increase the reimbursement the provider can receive from CMS for their active participation in increasing the population's health. For this reason, it will be important to educate care teams as to why these changes are occurring and to have administrative support of the needed changes.

Future Research

Future research contributing to this model needs to focus on alleviating the issues just presented. First, better data analytics technology that engages the care team by offering real-time suggestions for care has the ability to impact chronic care management at the point of care. Further research could enhance this model by investigating what data analytics care solutions currently exist, and how they could be incorporated into this model.

Second, any research into furthering data exchange standards for healthcare, such as the new FHIR standard, once implemented, could increase the ease of sharing and gaining access to clinical data between organizations. Continued research and development of using natural language processing to translate unstructured data into discrete data elements would be very beneficial to managing the large amounts of unstructured data currently inaccessible to data analytics.

Lastly, if population health workflows associated to this model could measurably make providers more efficient, this would go a long way in further adoption of the model. Further research is needed to research other organizations that have successfully implemented population health management, while also increasing provider satisfaction and streamlining their workflows. The outcome of such research could then be evaluated to see if it could be applied to the care management of this model.

Conclusion

Many forces are combining to move the healthcare industry away from the FFS reimbursement models of the past. The new models are value-based approaches, focusing on providing care towards increasing patient outcomes, reducing healthcare costs, and reducing over-utilization of services. Pressures to move in this direction will increase as more

organizations join ACO's, commit to risk-sharing contracts with private payers, and CMS implements more quality programs similar to MACRA.

The model presented in this project is directed at healthcare organizations looking to transition to a value-based reimbursement structure, while using data analytics to implement a more proactive population health strategy. The suggested implementation plan provides guidance to management and care teams as to the process of identifying an appropriate data analytics solution, and the structure needed for its use. Guidance is provided within this model to steer an organization on a path to being successful in the use of data analytics to increase the health of the patient population.

References

- AAFP.org. (2016). *Risk-Stratified Care Management*. Retrieved from <http://www.aafp.org/practice-management/transformation/pcmh/advanced/rscm.html>
- American Hospital Association. (2012). *Factsheet: Medicaid Provider Assessments*. <http://www.aha.org/advocacy-issues/medicaid/index.shtml>
- Bhattacharya, I., Ramachandran, A., & Jha, B. (2012). Healthcare data analytics on the cloud. *Online Journal of Health and Allied Sciences*, 11(1), 1-4.
- Bradley, P. (2012). Predictive analytics can support the ACO model. *Healthcare Financial Management: Journal Of The Healthcare Financial Management Association*, 66(4), 102-106.
- Bradley, P., & Kaplan, J. (2010). Turning hospital data into dollars. *Healthcare Financial Management: Journal Of The Healthcare Financial Management Association*, 64(2), 64-68.
- Centers for Medicare and Medicaid Services. (2016). *NHE Fact Sheet*. Retrieved from <https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/nhe-fact-sheet.html>
- Centers for Medicare & Medicaid Services. (2016, April). Retrieved from <https://www.federalregister.gov/articles/2016/05/09/2016-10032/medicare-program-merit-based-incentive-payment-system-mips-and-alternative-payment-model-apm>
- Chang, F., Nielsen, J., & Macias, C. (2013). Data key to quest for quality. *Hfm (Healthcare Financial Management)*, 67(11), 86-90.
- Elliott, A. (2011). Medicare as Technology Regulator: Medicare Policy's Role in Shaping Technology Use and Access. *Berkeley Technology Law Journal*, 26(3), 1489-1522.

- Eggbeer, B., Sears, K., & Homer, K. (2014). Partnering with payers? Key lessons to keep in mind. *Hfm (Healthcare Financial Management)*, 68(1), 84-89.
- Esperanza Lopez, M., Carberry, K., & Macias, C. (2015). Improving appendectomy outcomes using advanced analytics and team. *Physician Leadership Journal*, 2(6), 32-36.
- Finberg, H. (2012). A successful and sustainable health system – How to get there from here. *The New England Journal Of Medicine*, (11), 1020.
- Futrell, K. (2013). LIS of the future: supporting value-based measures for healthcare. *MLO: Medical Laboratory Observer*, 45(12), 8-12.
- Ghosh, B., & Scott, J. (2011). Antecedents and catalysts for developing a healthcare analytic capability. *Communications Of The Association For Information Systems*, 29, 395-410.
- Handmaker, K., & Hart, J. (2015). 9 steps to effective population health management. *Hfm (Healthcare Financial Management)*, 69(4), 70.
- Hannah, B., & Hancock, M. (2014). Determining your organization's 'risk capability'. *Healthcare Financial Management: Journal Of The Healthcare Financial Management Association*, 68(5), 74-79.
- Health IT. (2014). *About ONC*. Retrieved from <https://www.healthit.gov/newsroom/about-onc>
- HL7.org. (2016). *Introducing HL7 FHIR*. Retrieved from <http://www.hl7.org/fhir/summary.html>
- Jackson, J. (2014). Population health and the assessment of value. *American Health & Drug Benefits*, 7(5), 260-263.
- Klees, B., Wolfe, C., & Curtis, C. (2015). Brief summaries of Medicare & Medicaid: Title XVIII and Title XIX of the Social Security Act. Retrieved from <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MedicareProgramRatesStats/Downloads/MedicareMedicaidSummaries2015.pdf>

Landman, J. (2013). 'Value combos' for health care. *Hfm (Healthcare Financial Management)*, 67(5), 134-135.

Medicaid.gov. (2016). *ICD-10*. Retrieved from <https://www.medicaid.gov/medicaid-chip-program-information/by-topics/data-and-systems/icd-coding/icd.html>

Medicaid.gov. (2016). *Managed Care*. Retrieved from <https://www.medicaid.gov/medicaid-chip-program-information/by-topics/delivery-systems/managed-care/managed-care-site.html>

Medicaid Provider Assessments. (2011, September). Retrieved from <http://www.aha.org/content/11/110909-Tax.pdf>

Morgan, R., Teal, C., Hasche, J., Petersen, L., Byrne, M., Paterniti, D., & Virnig, B. (2008). Does poorer familiarity with Medicare translate into worse access to health care?. *Journal Of The American Geriatrics Society*, 56(11), 2053-2060.

Nugent, M. (2010). Payment reform, accountable care, and risk: early lessons for providers. *Healthcare Financial Management: Journal Of The Healthcare Management Association*, 64(10), 38-42.

Organization for Economic Cooperation and Development. (2016). *Health at a Glance 2015*. Retrieved from http://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2015_health_glance-2015-en

Sultz, H., and Young, K. (2009). *Health Care USA: Understanding its organization and delivery*. (7th ed.). Jones & Bartlett Learning. ISBN: 978-0-7637-8458-4

Ward, M., Marsolo, K., & Froehle, C. (2014). Application of business analytics in healthcare. *Business Horizons*, 57(5), 571-582.

Wills, M. (2014). Decisions through data: Analytics in healthcare. *Journal Of Healthcare Management*, 59(4), 254-262.