Chapter 23
The Role of Big Data and Analytics in Health Payer Transformation to Consumer-Centricity

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Abstract Historically, information management for payers has been focused on enabling efficient operations, such as claims administration and group management. Recently, with the rise of individual insurance and increasing pressure to reduce cost through better health management, healthcare payers are transforming its business to be increasingly consumer-centric. In the healthcare payer setting, consumer-centricity means to put individual consumer at the focus of payer operations. It is to understand and engage individual consumer throughout the insurance lifecycle, from assisting prospects to choose the most suitable product, engaging new enrollees in wellness, to assisting members navigate the healthcare system. In this chapter, we discuss the implications of consumer-centricity and external data explosion on payer information management, ranging from data management, analytics applications and use cases, to the analytics delivery platform. We also discuss how consumer data and open data support this transformation, shedding insights into range of business processes, and expanding the role of informatics in the payer organization.

Keywords Consumerism • Retailization • Health insurance • Managed care • Predictive analytics • Data platform

23.1 Introduction

Healthcare is following a similar transformation the financial and travel industries experienced over the last several years. The shift to consumer-driven health is evolving rapidly. Healthcare payers need to transform their operations, processes and culture to retain their members, stay relevant and manage costs. Consumer-centric healthcare is a way to approach, design and deliver healthcare by placing the customer experience and value above other priorities. The consumer

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experience includes the traditional patient experience, but expands across the continuum of care. Because consumers will be making the buying decisions, providers must increasingly think like retailers, whether it is in formulating marketing, pricing and risk management strategies, or in establishing new billing and payment practices.

Considering the consumer is important not only for the sake of improving the consumer experience – this strategy is critical to healthcare payers' financial and operational decisions and their ability to manage costs more effectively, grow their business and transition to outcome-driven organizations.

The rise of consumer-centricity in healthcare has been investigated from different perspectives. The work described in [3] discusses the consumer-centricity from the point of view of building trusted relationships and useful interactions between healthcare payers and their members; [11] discusses the implications of consumer-centricity in healthcare to finance functions, and highlights many of the ways payers and providers – including their treasury functions – will need to respond to prosper in this new environment. As payers begin to consider direct-to-consumer relationships, they will also have to address the automation and reengineering of their back-office processes and the underlying IT infrastructure. The need to understand the individuals better brings in new IT requirements and a need for far more detailed insights and information tailored to the individuals. As a result, Big Data and advanced analytics capabilities will become a key enabler in the success of the consumer-centric transformation in healthcare.

In this work, we provide an overview of the role of Big Data and analytics in this consumer-centric transformation. In Sect. 23.2, we discuss the background of healthcare payer function and driving forces of consumer-centric transformation. In Sect. 23.3, we address the implications of consumer-centricity in healthcare to payer processes and operations. We also provide several analytics use cases central to consumer-centric business processes and supporting data-driven applications. In Sect. 23.4, we address the information management strategy and roadmap needed to enable such transformation, from data management, analytics platform to API enabled shared services. In Sect. 23.5, we offer concluding remarks and future directions.

23.2 Background and Industry Trends

23.2.1 The Evolution of the Role of Healthcare Payer in the US

Health insurance in the United States has roots in the Civil War period and has grown and evolved with market need over times.

One of the first group policies giving comprehensive health benefits was offered in 1847 by Massachusetts Health Insurance of Boston. In 1929, the first modern

group health insurance plan was formed. A group of teachers in Dallas, Texas, contracted with Baylor Hospital for room, board, and medical services in exchange for a monthly fee. As the popularity of health insurance increased, several large life insurance companies entered the health insurance field in the 1930s and 1940s. In 1932, nonprofit organizations called Blue Cross or Blue Shield first offered group health plans. Blue Cross and Blue Shield Plans were successful with discounted contracts negotiated with doctors and hospitals.

In return for promises of increased volume and prompt payment, providers gave discounts to the Blue Cross and Shield plans. Employee benefit plans proliferated in the 1940s and 1950s, as influential unions bargained for better benefit packages and tax-free, employer-sponsored health insurance. During the World War II (1939–1945) wage freezes imposed by the government accelerated the spread of group health care. Prevented by law to attract workers by paying more, employers instead improved their benefit packages, adding health care. Government programs to cover health care costs began to expand during the 1950s and 1960s. Disability benefits were included in social security coverage for the first time in 1954. When the government created Medicare and Medicaid programs in 1965, private sources still paid 75 % of all of the health care costs. By 1995, individuals and companies only paid for about half of the health care, with the government responsible for the other half. During the 1980s and 1990s, the cost of health care rose rapidly and the majority of employer-sponsored group insurance plans switched from "fee-for-service" plans to the cheaper "managed care plans." As a result, most Americans with health insurance were enrolled in managed care plans by the mid-1990s. For more details in US health insurance history, see [15].

Through growing market adoption and consolidations, many of the early third party payer systems evolved and matured to today's healthcare payers. As of 2013, about 87 % of the US population is covered by health insurance offered by public or private health payers [24]. Amongst the insured population, about 55 % are covered by employer-based insurance, 38 % are covered by government-sponsored plans like Medicare and Medicaid, and less than 7 % are covered by non-group-based insurance.

Traditionally, healthcare payers focused their operations on providing support to their members through transactional processes and managing their risk through underwriting. Transactions included tasks such as looking up benefits, submitting claims, and searching for providers. Improving the efficiency of the transactions, especially claims processing, was the key lever behind running a successful healthcare payer organization. As a result, claims operations centers focused on the speed and accuracy of processing and paying healthcare claims, ensuring that providers were reimbursed in a timely manner, and that members received proper coverage, as prescribed in their health plans. Another critical focus area of payer operations was risk management. Risk management centers were established to ensure financial soundness of the insured portfolios, such that premium collected was sufficient to support the claims and administrative expenses and risk adjustment payments are properly accounted for. Given these priorities of the traditional healthcare payer role,

the organizational structure and underlying Information Technology (IT) and Information Management (IM) strategies was centered on maximizing operational efficiencies and ensuring financial soundness. Typical performance measures included claim cost per member per month and claims adjudication speed. Consequently, technology investments amongst healthcare payers typically focused on supporting group management, risk management and achieving operational efficiency.

23.2.2 The Affordable Care Act and Changing Landscape of Health Insurance

The passage of Affordable Care Act (ACA) in 2009 had significant impact on the US health insurance environment. With the overarching goal to expand access to insurance coverage, the ACA legislation directly impacts many of the foundational tenants of the healthcare system.

ACA requires most US citizens and legal residents to obtain health insurance; failure to compile results in penalties. ACA provided for the creation of public health insurance exchanges in all states. These exchanges, also known as "marketplaces," offer a set of government-defined and standardized healthcare plans from which individuals may purchase health insurance and be eligible for federal subsidies, thereby creating a boost in commercial individual insurance market. Individual insurance targets individuals who do not currently qualify for government-sponsored insurance and group-sponsored insurance, mostly the self-employed, employees of small businesses and unemployed. Enrollment in the healthcare exchanges began in October 2013. During the first open enrollment period of public health exchanges in 2013–2014, around eight (8) million Americans enrolled and the number is expected to increase to 25 million in 2017 and subsequent years [6]. Many Americans are expected to obtain healthcare insurance through privately administered health insurance exchanges, to which their employers are directing them. Published reports indicate that Fortune 500 companies such as Time Warner, IBM, Caterpillar and DuPont are among the companies using private exchanges for retirees or for certain groups of employees as a way to move toward a defined contribution model of healthcare benefits. In such setting, employers create a set of health insurance plan options through a private exchange, and their employees can choose a plan from participating payers. For employers, one advantage is they can continue to offer the company subsidy and some level of employee healthcare benefits in the form of pre-tax premiums, while controlling their costs.

As a result, the individual insurance increased from around 14 million members in 2011 to 20 million in 2014 [24]. The growth is expected to continue, reaching 26–73 million by 2020, corresponding to 8–22 % of the commercial insurance market [5]. Unlike group insurance, purchasing decisions are made by individuals (or families) and hence, require a consumer-based marketing, sales and retention approach.

In addition to creating the boost for the commercial individual market, ACA also introduced requirements that are altering how payers manage risk. For example,

ACA prohibits the maximum lifetime limits on individual and group health plans. It also requires the payers to provide essential benefits coverage, without the ability to differentiate premium pricing by medical history other than tobacco use. The legislation also prohibits payers to deny coverage for individuals, essentially removing the underwriting practice of the traditional commercial individual insurance. Finally, because of the wider availability of healthcare coverage, many previously uninsured Americans will enter the market, which will shift the health risk profile significantly, making traditional actuarial risk assessment practices based on historical data highly ineffective. Because of the new requirements, the traditional risk management approaches in insurance do not carry over to the commercial individual health insurance segment. This has increased the pressure on healthcare payers to manage cost and financial risk through non-traditional means.

To combat the increasing financial risk, payers are putting greater than ever emphasis on engaging individual consumers in health and wellness. For example the payers are:

- Actively engaging individuals in disease management,
- Enhancing their clinician engagement to promote chronic disease management and post-operations support,
- Expanding from healthcare management to wellness management, by offering gym membership, health products and wellness incentives,
- Empowering individuals to make better health and utilization decisions, by providing additional support during product purchasing process to ensure benefits alignment and to increase transparency in coverage and provider network.

In the pre-ACA era, consumers played the role of passive participant in the healthcare system, mainly due to availability of employer-managed healthcare coverage. Most employees paid moderate amounts in out-of-pocket cost, and they typically benefited from nominal co-pays and low deductibles. However, with the advent of consumer-directed healthcare in recent years, consumers found themselves equipped with more decision-making responsibilities. Today, with the implementation of the Affordable Care Act, consumers are being asked to be even more active healthcare participants, and have more at stake, both relative to their personal finances and their overall health. In the resulting consumer-centric healthcare business, in addition to being the end users and receivers of services, consumers will be making more of the decisions around the type of plan and coverage they select, as well as the doctors, hospitals and other providers they patronize. This fundamentally alters all key functional areas of payer operations.

23.2.3 Data as the Enabler of Consumer-Centricity

The consumer-centric engagement models and business processes require timely and relevant consumer information and data. Data was the accelerator of consumer-centricity in retail and financial sector, and today with the growth of consumer data in

healthcare, it is the lever of change in healthcare industry [7, 19]. In the current market, the sources and types of consumer data relevant to health insurance management are abundant and continue to grow. Beyond the more traditional healthcare data such as claims and electronic medical records, there has been a rise in non-traditional sources, such as retail marketing data, social media data and consumer controlled device data. Table 23.1 highlights the prominent sources of consumer healthcare Big Data and discusses their value in the consumer-centric payer operations.

Table 23.1 The description of various data relevant to healthcare payers

Clinical records	Contain clinical information about the patients from physician encounter notes, prescriptions, medical imaging, laboratory and testing. This information is captured in medical or patient health record The adoption of electronic records is increasing amongst service providers and in some cases made available to payers [12, 17]
Financial and utilization records	Contain healthcare service utilization information for individual health insurance member, associated costs and payment information. This information is typically captured in health insurance member, product and claims data Claims data includes records related to inpatient services, outpatient services and pharmacy fulfillments. It is submitted by the healthcare providers, and curated and processed by health payers' transactional systems. This data source is traditionally the most matured and available in payer operations
Direct consumer engagement records	Contain inbound and outbound member interaction data across channels, including phone calls, direct mail, text messages, emails and web chats. This information is typically captured in unstructured data format, and is rich with information around consumer preferences and concerns. The richness of this data source is growing steadily as payers increase proactive consumer engagement, as well as with the increase in direct communications via digital and mobile channels
Government and open data	Publicly available health and wellness statistics for different communities, which typically contain location-specific information gathered by government or non-profit agencies, such as access to care, access to public transportation, environmental data, healthcare benchmarks, disease prevalence, and etc.
Third party retail marketing data	Provided by data aggregators like KBM, Axiom and Epsilon, this data contains direct marketing information of individuals, such as retail purchasing history and statistics around socio-economic, education statues. Third party data allows payers to better understand prospects for marketing purposes, and enrich their understanding of members' preferences and attitudes
Social media	Contains self-generated data in the social media, including text, graphics and videos. For many active users, this is an extremely rich data source about lifestyle, preferences and behaviors However, due to privacy issues, it is often difficult to tie the data to individual members or prospects
Consumer controlled devices	Contains testing, sensing or self-reported device managed data, generated by consumer controlled digital devices such as blood glucose monitor, activity tracking devices, digital scales; and by consumer reported data from mobile apps and web services (for example iHealth)

Big Data in consumer healthcare offers tremendous information for payers to understand consumers personally and anticipate their upcoming health and wellness needs. The range of potential applications is broad, spanning all business processes of a payer. For example, healthcare utilization records can be combined with retail marketing data to understand individual's propensity for behavioral change. Consumer communication preferences can be extracted from past engagement records to determine best channel for messaging and engagement. Census, open data and healthcare surveys can indicate general healthcare trends or help benchmark different geographical segments and markets. (In Sect. 23.4, we will discuss several use cases in more details). Payers who successfully manage this diverse data, have capabilities to extract relevant insights and use them effectively in their operations, will have a significant competitive advantage in the new environment.

23.3 Consumer-Centricity in Healthcare Insurance

Consumer-centricity in health care payer setting is defined as creating a positive consumer experience at every point of health insurance operations, from sales and marketing, product selection, health insurance utilization, to customer service and care coordination. The emphasis is on providing a personalized experience that is relevant and timely, such that the payer can acquire and retain customers, and engage and empower members to make the best health insurance and care decisions. In the emerging consumer-centric healthcare environment, payers will face a number of challenges and unknowns. For example, because consumers will be making buying decisions, payers must increasingly think like retailers, whether it is in formulating their marketing strategies, performing care management or establishing new billing and payment practices. The emergence of an empowered healthcare consumer calls for payers to develop an entirely new mindset of running the business, focused on winning over consumers and improving outcomes. Some call this paradigm shift the "retailization" of healthcare [3].

The consumer experience starts when an individual is a prospect, a target for the sale of a health insurance product; as the sales cycle matures, the individual is considered a lead, who has expressed an intent to buy and is interested in learning more about the product. As the individual completes the product enrollment process, he/she is an enrollee and transitions into being a member and begins consuming various health insurance services. At the end of the insurance product coverage period, the individual may decide to re-enroll or not. Member who decides to discontinue coverage is considered a dis-enrollee. The stages of prospect, lead, enrollee, member, dis-enrollee constitute the consumer lifecycle. Consumers have different needs and expectations at each stage of the lifecycle, calling for different servicing capabilities.

Table 23.2 The characteristics of consumer-centric actions and experience throughout the lifecycle of a healthcare customer

Prospect	Create the basic profile of the individual to understand key characteristics and tailor relevant marketing messages. Engage through a channel that best resonates with particular individual
Lead	Understand individual's personal and family insurance needs, for example, affordability concerns, coverage requirements Offer product options, for example, the ability to "mix and match" product features
Enrollee	Enrich the profile with the information collected at the point of enrollment and (for former members) from historical data. Offer new enrollee orientation, including detailed product and benefits education Tools and support to enable searching and comparing service providers, and performing financial analysis and planning
Member	Enrich the profile with the information collected via service consumption. Provide customer service support best tailored to the individual. Provide access to wellness and care coordination support that is relevant to individual's conditions and lifestyle. Help with life events, including re-alignment to different products, ability to choose new physicians or service facilities
Dis-Enrollee	Close out billing in timely manner. Properly archive the member records and ability to retrieve and map past records if/when the individual returns in the future

Table 23.2 describes the characteristics of a consumer-centric experience throughout the lifecycle.

23.3.1 Consumer-Centric Business Processes and Analytics Applications Use Cases

Enabling the consumer-centric experience across the lifecycle requires a new set of analytical capabilities. For example, traditionally, payers relied on direct mail marketing campaigns to target prospects of Individual products in certain geographies. Today, to enhance how they communicate with consumers in the Individual market, payers are expanding their engagement channels to include email, social media, and brick-and-mortar retail stores [2, 4]; this requires new insights on consumers' channel preferences and promotional triggers, the ability to capture responses from these new promotional practices and continuously learn and evolve based on derived insights.

Once an individual makes the purchasing decision and becomes a member of a health plan, the consumer experience continues. While business functions supporting the different stages of the consumer lifecycle vary, payers need to provide consistent and relevant experience throughout the lifecycle, and take advantage of the additional consumer data made available over time. This transformation has significant implication to information management strategy in the payer organization.

It also calls for a range of innovative data and analytics-driven applications in support of the diverse business processes. From improving personalized engagement for care management, to supporting core business functions around flexible risk management and financial planning, there is a broad spectrum of opportunities to create new insights and enhance decision making in a way that has not been done before. Table 23.3 provides examples of analytics use cases at different stages of the consumer lifecycle.

In the following sections, we discuss four analytics use cases in more details. *Prospect Risk Prediction* discusses gaining a predictive view of non-member health risk to improve marketing and product design decisions. *Evolving Consumer Segmentation* highlights the analytics needs and approaches to formulate enterprise wide consumer segments, which are adaptive to the different stages of the consumer lifecycle. *Care Engagement Targeting* focuses on the analytics capabilities to identify "who" the payers should engage with to improve member health. *Behavioral Change Analytics* focuses on analytics supporting insights around "how" to engage the targeted individuals and "what" are the best triggers and enablers to improve wellness.

23.3.2 Prospect Risk Prediction

The insights around prospect risks are critical in decisions around market entry and product design and pricing. As discussed in Sect. 23.2, ACA has expanded health insurance access for the previously uninsured individuals and its requirements for health plan benefits are likely to induce different consumption habits compared to previously insured individuals. This will change the risk profiles of the population payers insure, and to mitigate and manage potential financial risk, payers need to improve its ability to understand prospects' risks. Historically, prospect risks are evaluated for different geographies using basic demographic data such as age, gender and tobacco consumption.

However, the predictive ability of models using these basic factors tends to be limited, especially with fundamental shifts in the insured population [9]. To overcome these shortcomings, payers are beginning to explore the use of non-traditional data in modeling consumer risks, such as publicly available location data and retail marketing data. Individual prospect information, such as household size, financial stability, behavioral and life style choices, which can be derived from Census and consumer data, have shown to correlate with healthcare risk [22].

Leveraging these non-traditional datasets poses several predictive modeling challenges. The datasets tend to have hundreds and sometimes thousands of fields that are: (1) sparsely populated (e.g., self-reported health conditions), (2) highly correlated (e.g., estimated income and education level) and (3) have different levels of granularity (e.g., access to care is tied to geography, whereas ethnicity is tied to an individual). As a result, extreme care needs to be taken in selecting analytical methods, in feature engineering and in handling of the missing values.

Table 23.3 Analytics uses cases at different stages of the consumer lifecycle

Business functions	Targeted consumer stage(s)	Analytics use case objectives
Omni channel direct marketing	Prospects	Improve direct marketing effectiveness through more effective prospect targeting and touch point optimization
Personalized sales	Leads	Increase sales close rates through insights into "triggers to buy" and communication preferences
		Optimize product-to-individual alignment through insights around individuals' health insurance needs
Product design	Lead Enrollee Member	Improve shopping and utilization experience with simple and attractive product offerings
		Empower members to have access to the right care provider at the right price
Member engagement and empowerment	Enrollees Members	Improve customer satisfaction and
		loyalty with consistent, timely and relevant communications
		Empower consumers to understand options for health services and insights into provider's quality and cost
Customer service	Enrollees Members	Improve self-service offerings to empower consumers and optimize user experience across channels
		Support proactive issue resolution by mining communication data
Financial management	All	Predict prospect and member risk and detect early indicators of cost drivers using relevant member information
Care coordination	Enrollees Members	Improve patient outcome by sharing relevant and timely patient insights with appropriate healthcare service providers
Care and wellness management	Enrollees Members	Improve disease management and promote population wellness through personalized insights on health behavioral change triggers, incentives and intervention effectiveness

While these non-traditional datasets coupled with new predictive modeling techniques have tremendous potential to help payers understand prospect risk better, the insights derived through analytics need to be leveraged appropriately. The outputs of the predictive models tend to be probabilistic and do not hold the confidence level of medical or clinical data. When lifestyle or socio-economic data are linked to healthcare information, extreme care should be taken to protect patient privacy, and ensure that the insights are not used to disadvantage consumers in any way.

23.3.3 Evolving Consumer Segmentation

For a long time, consumer segmentation has been the underpinning to providing consistent and relevant consumer experience to individuals in many industries, including healthcare insurance. In managing prospects and leads, segmentation provides consumer insights for effective marketing. After prospects become members, segmentation is used to understand their healthcare needs and preferences, and to improve customer loyalty and engagement effectiveness. Moreover, understanding how demand drivers and utilization differ from segment to segment allows insurance companies to tailor products and services to meet demand, improve care and retain loyalty. Payers can utilize consumer segment insights to provide value-added services, for example, discounts to health clubs, monthly heart-healthy recipes sent to member email addresses, appointment reminders with GPS directions on mobile phones, mobile reminders for prescription drug schedule updates, applications that track glucose and blood pressure readings, and automatic emails to doctors.

Historically, each business function of a healthcare payer relied on its own consumer segments, thereby creating numerous disjoint consumer segmentations across business units. This often prohibits an enterprise-wide consumer strategy. Different amounts of data about the healthcare consumer are available at different stages of the lifecycle, and the ability to derive insight about the consumer increases from the basic demographic information and third party data, information collected at the enrollment, to detailed health service consumption information once the individual starts utilizing the service. Rather than being a set of disjoint analyses, effective consumer segmentation model needs to reflect this data build-up, while maintaining sufficient stability for cross-business function coordination.

This creates additional requirements on the analytics applications, and calls for the use of robust hierarchical segmentation techniques, capable of handling the increase in member information throughout the lifecycle, and also capable of creating highly targetable segments of various granularity: from a small number of coarse segments used in strategic planning and business assessment, to a large number of actionable micro-segments for use in tactical decision-making.

The segmentation models also need to be capable of handling disparate member data, and creating interpretable insights to support data-driven intelligent member marketing, product design, risk assessment, program design, actuarial pricing, provider and hospital relationship management.

23.3.4 Care Engagement Targeting

Engaging members regarding care management has proven benefits in population health management and lowering overall healthcare spent [10, 16]. Payers have access to longitudinal and digitalized records of members' healthcare utilization

data across providers, and are financially motivated to engage members to avoid future high cost expenses.

For example, with the goal of minimizing hospital readmission, a Cleveland health plan assigns care counselors to members who have recently been discharged from the hospital to ensure that they understand discharge instructions and identify any potentially unmet needs [8].

Historically, payers identified members for care management efforts by relying on extensive member clams history to conduct retrospective utilization review or predict future high cost claimants [25]. However, with increases in health risk diversity in membership, and with increasing pressure to curb healthcare costs, payers are taking a more proactive role in identifying members for care engagement. The need is intensified with the arrival of previously uninsured or underinsured members, who tend to be less familiar with condition management and might be less knowledgeable about factors and considerations important in choosing the right healthcare providers and treatments.

To take a more proactive and targeted approach in care engagement, payers can incorporate analytics-driven insights focused on early identifications of members who would benefit most from the engagement efforts. For example, payers can greatly improve the effectiveness of the outreach programs by identifying potential high cost individuals shortly after the enrollment, thereby increasing the intervention time window. For example, by analyzing pharmacy data in the first 2 or 3 months of the membership, it is possible to build early risk profiles or apply predictive modeling to identify individuals who are likely to incur high cost in the remainder of the year. Another opportunity to use predictive analytics is in identifying individuals at high risk of progressing in their disease conditions, or identifying members whose chronic condition are likely to deteriorate, thereby enabling more aggressive outreach measures to engage and motivate these members to better manage their conditions. Such highly personalized early insights require analytics capabilities that are capable of deriving longitudinal view of individual members' clinical and behavioral conditions. This also calls for sophisticated data handling and feature-engineering methods, such as data densification and temporal data sequencing [26, 27].

23.3.5 Behavioral Modification Analytics

Studies have shown that more than 31 % of US healthcare expenses can be directly attributed to behaviorally-influenced chronic conditions [7].

Healthcare expenses can be avoided with changes in individual behavior, including medication adherence, practicing safety measures, dietary practices, physical exercise, and etc.

While payers have tremendous interest in reducing these avoidable costs and promoting wellness, behavioral modification is fundamentally personal and requires consumer's individual self-regulatory and health enhancing efforts.

To affect behavioral modification effectively, payers cannot simply rely on one-size-fits-all programs or tools, but need to: (a) gain personalized insights around motivations that drive individual behavioral changes, and (b) identify proper incentives that can trigger such changes.

For example, to improve medication adherence in chronic diseases like diabetes, payers need to first understand the non-adherence reasons and potential barriers by mining through population health literature or by conducting observational studies. Some diabetic patients may be non-adherent due to lack of awareness, which can be impacted through consumer monitoring devices, while others may be non-adherent due to financial constraints prohibiting them from getting refills in a timely manner, which can be impacted through discounts programs.

Besides relying on domain expertise and extracting knowledge from the existing literature, personalized insights affecting behavioral change can be derived through mining observational data. For example, by analyzing member response patterns to various interventions, payers can apply predictive modeling techniques to estimate how likely a given member will respond to certain types of interventions. Another opportunity is to combine healthcare utilization and consumer device data to identify the most effective "triggering" moments that influence behavioral change. Furthermore, with sufficient member engagement history, it is possible to utilize stochastic process modeling techniques to determine the most effective "nudge" at any given time to optimize long-term wellness.

Lastly, behavioral modification is also highly social and culturally driven. There are opportunities in mining social media data to understand different consumer segments' perception and motivation of health and wellness.

Moreover, by applying network science, one can identify individuals who can most influence certain community's behavior [23], from determining who in a family network can best improve a child's asthma medication adherence, to identifying the influencer in an employee group to promote physical activities.

23.4 The Implications to Information Management Strategy

To enable the consumer-centric transformation, payers need to understand individuals across the consumer lifecycle and the view needs to be coherent and transparent to the various business functions, from marketing, sales, claims management, customer service, to care coordination.

This requires bringing together data across the various business functions, and tapping into data sources both internal and external to the enterprise. Some of these data types are structured, which follow predefined formats like the internal claims data or Census surveys, while other data types are unstructured, such as text, image and video customer service call recordings or social media data.

Figure 23.1 provides the consumer data management landscape for a typical health payer organization, based on the origin of the data (internal vs. external) and format of the data (structured vs. unstructured).

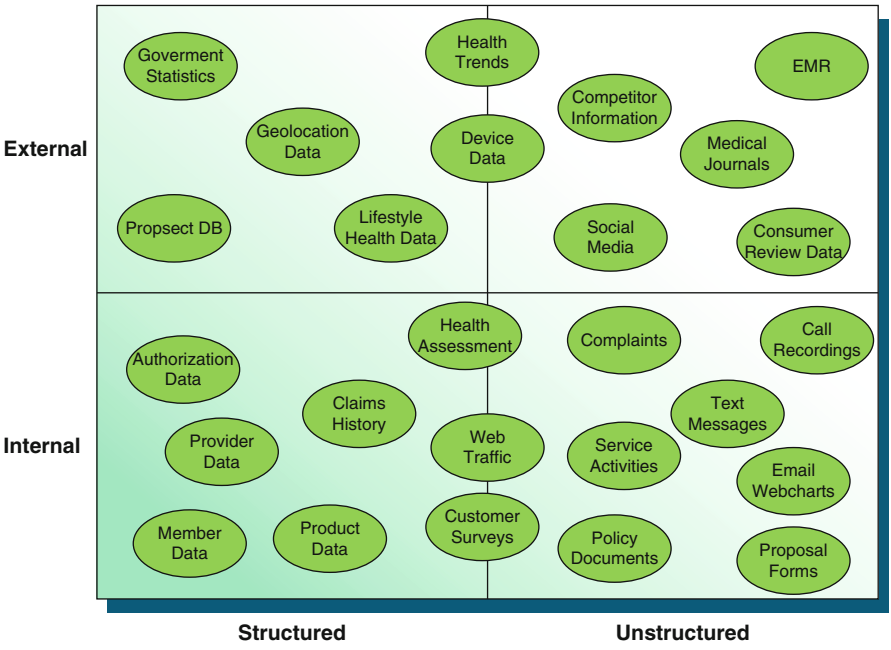

Fig. 23.1 Data landscape for healthcare payers

23.4.1 Consumer-Centric Data Management

Payers had historically relied heavily on internal data for its operations and the corresponding data management method had been group-centric and transactions driven. As illustrated in Fig. 23.1, the internal data is typically derived from administrative function, such as application and policy documents from enrollment, claims history from adjudication and payment processing, and call recordings from customer service.

A common challenge is in turning the internal and structured administrative data from a transaction-centric view to a consumer-centric view.

In a consumer-centric view, data generated throughout the different transactions and contacts are captured and managed around the consumers, and consequently, data about the individuals are made available in a relevant and cohesive manner as different business functions interact with customers or manage consumer-related activities.

Instead of a group-centric approach, the consumer-centric data management strategy needs to transpire across both membership affiliations and business functions. As individuals move between different products, employer groups or between group-based and individual-based plans, they need to be tracked as the same unique consumer and the consumer view is continuously updated and enriched.

This requires data management capability that matches consumer records and reconciles consumer information across disparate sources of data. Many payers have adopted custom or commercially available master data management tools to create and maintain such consumer-centric data view.

With the increasing need to market to prospects and engage with individual members, payers are also expanding their use of external data to gain insights on consumer preferences, health trends and socio-economic characteristics of different geographies and population cohorts. In the US, there has been a significant focus around gathering open data related to healthcare. Data.gov/health provides a collection of Federal, state, local and non-profit collected and derived data related to healthcare. Prominent sources include CDC Health Statistics Report and Census's American Community Survey, which provide population-based information around socio-economic status and healthcare utilization. Other countries have similar initiative (see for example, HSCIC.gov.uk in Great Britain, and data.go.jp in Japan). In addition to open data, payers have also shown successes in leveraging consumer retail databases like Acxiom, KBM and Epislon in their marketing, risk and care management efforts. For example, UPMC utilizes household level retail data, such as education level, marital status, and number of cars, to improve its emergency and urgent care forecasting capabilities [21]. Similarly, an East Coast health insurer identifies patients who are likely to have scheduling and logistical constraints with their regular doctor's appointment, and hence might be at increased risk of hospitalization [14].

In addition to consumer retail data, social media data from social networking sites such as Facebook or Twitter, are another source of timely and personal data about individual consumers, offering insights such as intent to relocate, lifestyle habits and changes, or stress level indicators. Recent advances in information management, text analytics and entity resolution show promising results in linking sparse social media data with customer service records [1].

Despite tremendous potential in leveraging external data to improve consumer experience and personalize service and care, privacy concerns pose limitations in linking external data to individual insured members. Moreover, not all external data can be easily tied to a specific individual or household. For example, open data such as publicly available survey data published by CDC or Census are reported at different geographical summary levels. To effectively derive insight from such data, the data management platform needs to have the flexibility to support integrating external data in an agile manner, depending on different analytical and functional needs and privacy requirements. For example, certain types of analyses will be carried on the consumer location data, while other might operate on the granularity of consumer segments.

Another significant data management challenge includes curating, integrating and analyzing unstructured data from combined internal and external sources. Unstructured data generated from consumer interaction like call center, web chat and email, captures consumers' stated preferences, their perceptions and relationship with the health plans and providers. These insights can be integrated with

member record to improve engagement effectiveness like wellness programs and cross selling.

Another major source of unstructured data is clinical or device records like EMR or consumer-driven health mobile apps, which can greatly enrich the transaction-based data like claims records in care coordination and behavioral modification programs.

The nature of unstructured data is highly contextual and the deployment of analytics tends to require heavy involvement of subject matter experts. Recent advances in Natural Language Processing (NLP) technologies provide efficient ways to analyze human languages inherent in data generated throughout consumer and patient interactions. NLP translates between natural and computer languages by identifying text-based concepts, user sentiments, and to find latent meaning and relationships hidden in unstructured data. The information is captured and codified to enhance payers' view of the consumer and can be leveraged to improve predictive modeling efforts.

23.4.2 Agile Analytics Platform

In order to transform the growing volume and variety of consumer data into business actions, it is imperative for payers to increase the maturity of analytics technologies focused on mining, analyzing and predicting from consumer insights. Some of the key challenges include:

- The supply chain on consumer data is dynamic and goes through ongoing changes. New data sources of consumer information are constantly made available through new business partners and data providers. Moreover, external data sources differ in quality and can affect the content and schema without notice.
- Different business processes that utilize the same data may require similar but not identical sets of data elements, reports and analytics. However, it is expensive and ineffective to have duplicate data and capabilities.
- Consumer engagement requires timely insight. For example, members expect care management clinician to be aware of their latest medical treatments and wellness program activities. However, many existing analytics platforms rely on batch updates and are not instrumented for near real time performance.
- From the traditional electronic medical records to social media to consumer interaction data, the amount of unstructured data is growing in volume and complexity. The data sources contain tremendous insights around individual consumers' clinical, behavioral and preferential information, but most payers have limited experience in managing and analyzing these types of unstructured data.
- The needs of business user are fluid and constantly evolving. They are highly dependent on changing competitive landscape, business strategy, political environment, consumer trends and emergence of new technologies. To assess the effectiveness of new analytics, prototype of new capabilities needs to be developed and implemented quickly as an enterprise-wide solution to generate

business value. On the other hand, the analytics need to be adaptive to changing business needs.

These challenges call for a new generation of analytics platform, armed with features such as:

- Ability to allow expert users to quickly explore and analyze new data sources. Growing in popularity is the utilization of storage repository like data lake which retains all attributes using light data governance principles. An example of data lake storage is Hadoop-oriented object storage where metadata is captured to facilitate analysis design without pre-specification of data requirements. This allows experts like data scientist and skilled business analysts to work with raw data directly. It enables quick exploration of data value and quality that are use case specific.
- Ability to access the same data and analytics modules for different business needs, enabled by a flexible API services model to allow different users and different business processes to share the same data, reports and analytics.
- Ability to extract insights quickly and effectively, supported by the use of parallelized data processing capabilities to reduce latency (as opposed to the traditional nightly or monthly data warehouse updates), or use of stream processing technologies to aggregate and analyze data in motion.
- Ability to efficiently conduct semantic search and enable content analytics on unstructured data to enrich learning from the more traditional data sources. One way of achieving this is to leverage a data management standard like Unstructured Information Management Architecture (UIMA) to enable interfacing of different text analytics solutions with the enterprise data.
- Ability to accelerate the deployment of complex analytics solutions by leveraging Dev/Ops approach to development and deployment of predictive analytics to facilitate the maturation from prototype to scalable production-grade capabilities. One way of achieving this is via implementing enterprise-wide core analytics foundations, such that data scientists, analysts and developers all utilize the same business-driven data model and common analytics toolsets.

23.4.3 Other Implications

More than ever, consumers are seeking the right information delivered in an easy to use decision support tool to assist them in their health care decisions. Consumers' expectations in healthcare are shaped by their consumption experience in other industries, most notably retail, banking, travel and telecommunications, where consumer needs are increasingly influenced by digital channels such as web, mobile and social media. For example, more than 75 % of consumers noted that they are willing to sign up for a mobile app or website to help them adhere to their doctor's treatment plan and track their health goals [13]. To meet such consumer expectations, payers need to compete on multi-channel presence and quality of

experience. This includes mobile tools, website content (design), social media participation, consumer surveys and customer support. As a result, in the highly competitive new market, payers need to rethink consumer engagement methods from grounds up, and use growing consumer ownership and accountability to drive sustainable behavioral change, improved outcomes and lower cost of healthcare.

With access to most of the utilization and provider data related to healthcare activities for their insured members, payers are uniquely positioned to act as the information hub and healthcare solution agent. In parallel to maturing their consumer-centric data management and analytics platform, payers are expanding their consumer engagement platforms, ranging from self-service portals, mobile health platforms, social media engagement and gamification, to alternative care delivery platforms.

- **Self-Service Portals:** Omni-channel platform enable consumers to seek information related to their healthcare utilization decisions, from product selection, to healthcare service provider comparison, to wellness choices. Such platforms include information around product features, quality and price of care, delivered via interactive platform that supports diverse queries (e.g. regarding coverage, provider search). Furthermore, the complexity of the ACA and the surge in the number of people seeking insurance is driving the increase in the healthcare plan call center workload, and impacting the quality of service. Many elements of this process can be successfully diverted to the digital channels and self-help mechanisms, which will drive a new wave of digitization of customer care. Examples include: educational aid, online tutorials, online self-service kiosks, insurance calculators, online discussion forums, intelligent virtual shopping assistants, independent consumer surveys, etc.
- **Social Media Engagement and Collaboration Platforms:** Healthcare consumers are seeking information on the Internet and in social media space to make informed decisions on their healthcare choices. An increasing number of individuals are willing to share their healthcare experiences and learn from others. Healthcare payers have increasingly leveraged social media and social collaboration platforms to continuously engage with consumers [20]. They can further enhance consumer experience through collaboration platforms enabling conversation between consumers, providers and prospects. The critical factor shaping the requirements for collaborative platforms in healthcare is HIPAA, which dictates how privacy and personal information is to be managed between various stakeholders in the healthcare industry.
- **Mobile Health Platform:** Utilization of mobile health (mHealth) platform facilitates the exchange of information, diagnosis, treatment, and monitors through phones and mobile devices from millions of individuals, which has enormous potential to lower the cost of health interactions and improve overall quality of care [18].
  - Healthcare, unlike many other industries, is almost entirely delivered by physical interaction between patients and health professionals. Furthermore, many diseases require multiple professionals to be engaged in diagnosis, treatment and follow-up. This need for co-location is manageable for episodic healthcare interactions. However, for chronic diseases, which require constant

monitoring, this is not only inconvenient, but also expensive, which often prevents patients for getting ideal care. The promise of mobile health is the ability to achieve co-location through technology solutions, allowing patients and health professionals to interact without the need to be in the same place. mHealth platforms will allow secure connection of multiple devices to data management and storage systems, which can be interrogated remotely by health professionals or expert systems.
  - Payer can enable or partner with mhealth platform to enable its member to interact with healthcare service providers, from basic interactions such as voice, video or text-based messages, net-based information resources, or reminders generated by expert systems, all the way to sophisticate ones, such as remote sensors (e.g. heart or glucose monitors), smart pill dispensers, RFID tags which can sense when a pill has been swallowed, or "smart pills" that can monitor vital signs as they pass through the body.
  - The ability to have ongoing interactions with multiple service providers via mobile devices is particularly beneficial in managing chronic or high-risk conditions like diabetes, respiratory and cardiac disease.

- **Gamification:** Smartphone users in the US spend an average of 158 min on their phones every day, with gaming taking up to 50 min (32 %) of that time [13]. The ability to apply gaming concepts to real-life tasks, is taking off in many fields, showing potential to improve learning, skill adoption and behavioral change. In healthcare realm, gamification, in form of wellness apps, can be applied to promote healthy lifestyles and improved self-care. Private insurers are beginning to develop mHealth apps, that drive behavioral change, for example, UnitedHealthcare has developed BabyBlocks, a game that incentivizes Medicaid moms to stick to their prenatal checkup appointments, while Aetna has launched CarePass, a platform that aggregates data from different health and wellness applications, within unified dashboard customized to the user.

This anticipated explosion of mHealth and Alternative Care Delivery Platform will result in widespread reliance on distributed file systems (for example, Apache Hadoop) to store vast amounts of personal health data, images, video, GPS data, and chat logs for streamlined indexing and processing. Access to all of this rich, personal data, including sensors, health monitoring readings, and auto-alerts when readings go over thresholds set by physicians, in a real-time shared scenario creates exciting opportunities for traditional healthcare analytics to scale up to meet the big healthcare data challenge.

23.5 Conclusion

Health insurance industry in the U.S. has traditionally been group and transaction-focused. With the recent market changes driven by the ACA and the pressures to manage healthcare cost and improve outcomes, many U.S. payers are undergoing

the consumer-centric transformation, and making consumer experience and value delivery the number one priority. This transformation requires fundamental shift in how payers manage their businesses, from organizational culture, business processes, to how they use technology as an enabler of more informed and agile operations.

As payers begin to interact with individual consumers throughout the consumer lifecycle, as they take more active role in impacting and changing healthcare behaviors, the need for scalable, timely and agile analytics capabilities to inform and support these dynamic interactions continues to increase. In this chapter, we described how the ever-increasing needs and expectations of healthcare consumers impact different business processes of a healthcare payer, and we highlighted the improvements that can be achieved by applying insights derived with advanced analytics.

While there are some success stories on how payers leverage new data sources or novel analytics methods in this transformation, these successes are not widespread in the industry and tend to impact limited number of business functions within the organization. As payers continue on the journey of consumer-centric transformation, the industry can benefit from in-depth case studies of individual payers' experience and lessons learned from the deployments of enterprise-grade Big Data solutions and predictive analytics platforms.

The primary focus of this work relates to payers' direct engagement with individual consumers. Another potential area for future work is to better understand the role of information technology, advanced analytics and collaborative solutions, as payers engage different players in the healthcare ecosystem to enable consumer-centric business model. The ecosystem players range from traditional service providers (e.g. hospitals, physicians and rehab centers), to social and home services (e.g. social workers and home care), to emerging digital health service providers (e.g. wellness device providers, mobile app developers and data curators).

Payer can greatly benefit from coordinating with these health and wellness providers in motivating and supporting consumer's health journey. There are many open questions, for instance, about how to best gather, synthesize and share information across the magnitude of service providers to improve consumer health and retention, how to improve analytics methods in deriving insights based on data from increasing number of sources, how to leverage the emerging API marketplace to improve payer's consumer-centric operations, and etc.

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