HARVARD BUSINESS SCHOOL

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

9-515-060

REV: SEPTEMBER 8, 2015

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Carolinas HealthCare System: Consumer Analytics

In 2014, Dr. Michael Dulin, chief clinical officer for analytics and outcomes research and head of the Dickson Advanced Analytics (DA^2) group at Carolinas HealthCare System (CHS), was preparing for a planning meeting with Carol Lovin, executive vice president and chief strategy officer at CHS. In the three years since DA^2 was formed, the team had successfully unified all analytics talent and resources into one group that served CHS. Rapid increases in computing power and decreases in data storage costs had enabled DA^2's data architects to build predictive models incorporating complex clinical, financial, demographic, and claims data that would have been impossible to create only a few years before. Although DA^2 had blazed the trail for applied analytics in healthcare, other players in the value chain were making increased investments in their own modeling capabilities.

Healthcare payers, such as Humana and UnitedHealth, were increasingly making analytics the focus of a strategic shift toward consumer-centric healthcare, going so far as to create targeted communications strategies for different patient segments and engaging behavioral health companies to provide exercise, nutrition, and other programs that would reduce the healthcare costs of their highest-risk patients. While many agreed that analytics could help the healthcare industry reduce costs and increase access to care, CHS recognized that privacy protections on patient data, as well as competitive rivalries, restricted the sharing of data among the various healthcare stakeholders.

Dulin also noted the entry of consumer tech companies into the healthcare space; in 2014, both Apple and Google announced features in their new mobile operating systems that aggregated and tracked the output from various health wearables (like heart-rate monitors or step counters), as well as electronic medical record (EMR) data. Apple's HealthKit could even incorporate the results of lab tests into the dashboard (with the user's permission). Although the tech giants did not yet have access to claims or clinical data, they could potentially enter the field by acquiring an EMR company. Their expertise in analytics, access to demographic and location data, as well as the broad consumer adoption of their devices, led Dulin to consider which industry players consumers would trust to integrate their healthcare data in the future and what role DA^2 could play.

Professor John A. Quelch and Research Associate Margaret L. Rodriguez prepared this case. It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. . Professor Quelch is the Charles Edward Wilson Professor of Business Administration at the Harvard Business School and Professor in Health Policy and Management at the Harvard T.H. Chan School of Public Health. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

Carolinas HealthCare System Background

In 2014, the Carolinas HealthCare System, headquartered in Charlotte, North Carolina, owned and managed hospitals and acute care facilities that served over 2.2 million patients[a] per year across three states (North Carolina, South Carolina, and Georgia). CHS was one of the oldest healthcare systems in the U.S.; its origins could be traced to the state's first civilian hospital, Charlotte Home and Hospital, established in 1876. The Charlotte Home and Hospital operated until 1940 (although the name was later changed to St. Peter's Hospital), when it was replaced by a new facility, the Charlotte Memorial Hospital, in a different location. During World War II, the hospital's financial difficulties led Rush S. Dickson, a local businessman, to lobby the city and county governments for larger reimbursements for emergency and indigent patients, and solicited financial support from local nonprofits and corporations. In 1943, the Charlotte-Mecklenburg Hospital Authority was organized under the North Carolina Hospital Authorities Act, which provided for oversight mechanisms for Charlotte Memorial Hospital (including rules governing the construction of new facilities, funding, and management of day-to-day operations). The act also provided the legal and financial frameworks to support patients who could not afford to pay for healthcare services.

In 1990, the name of the Charlotte Memorial Hospital was changed to Carolinas Medical Center (CMC) to reflect the hospital's increasing focus on education. That year, the facility was designated an "Academic Medical Center Teaching Hospital" by the state of North Carolina (one of only five hospitals in North Carolina to receive the designation). Five years later, the authority changed the name of the growing hospital network to CHS. In 2007, CHS opened the Levine Children's Hospital, which housed more than 30 medical specialties. In 2010, CHS announced a 10-year, $500 million investment to advance cancer treatment strategies and research through the creation of the Levine Cancer Institute. In 2010, CMC (now a part of CHS) was designated the Charlotte Campus of the University of North Carolina (UNC) School of Medicine and hosted third- and fourth-year medical students.

By 2014, CHS had become the biggest healthcare provider in North Carolina, with more than 61,000 full-time and part-time employees and an annual budget of over $7.7 billion (see **Exhibit 1** for selected financial data). Its medical education and research center included over 300 residents and fellows pursuing a variety of medical specialties and had established research relationships with Oxford (stroke), UNC (dementia), Duke University, and many other academic centers across the U.S. CHS operated 900 care locations and 7,494 licensed beds in three states, including 39 hospitals (21 of which were managed by CHS, and 18 of which were owned), as well as additional virtual care services. Roughly 75% of patients were located in North Carolina, and CHS spent $20 million each year on community outreach in the greater Charlotte area alone. CHS tracked patient satisfaction with mailed surveys or follow-ups within days of an appointment or discharge. Satisfaction was measured by a patient's likelihood to recommend CHS. As part of its role as a public healthcare system, CHS provided healthcare services to underserved patients and communities. CHS offered financial support to patients without insurance (or who were underinsured), subsidies for Medicare and Medicaid recipients, as well as funding for its education, behavioral health, and community health clinics. CHS gave medical supplies and equipment to nonprofits valued at over $1.5 million in 2013 (see **Exhibit 2** for a full list of CHS charitable expenditures for 2013). Roughly 62% of annual revenue came from Medicare and Medicaid patients.

[a] Patients were considered active if they had engaged with one of the CHS sites (including primary care facility, hospital, worksite clinic, a virtual visit, or a trip to a clinic inside of CVS) at least once in the prior 18 months. Roughly 13,000 patients fell off the active rolls each month, many due to relocating out of state, death, or attrition.

By 2014, the vision of CHS had remained unchanged for two decades: healthcare, education, and research. That year, Lovin led an initiative to renew the strategic road map to guide CHS's future growth. She worked with her executive team colleagues to craft a strategy that provided for personalized, high-quality service across a single, unified enterprise. "Our customers are the consumers and patients first, payers second," said Lovin. The team developed a list of strategic priorities (see **Exhibit 3**) and performance measures (see **Exhibit 4**) to guide the organization toward its goals.

Health Provider Industry Background

In 2012, healthcare expenditures in the U.S. totaled over $7,600 per capita versus an average of $2,800 per capita among OECD countries.[1] The majority of healthcare expenses were paid for by government-sponsored coverage, such as Medicare and Medicaid,[b] or by health insurance companies that sold plans to employers and individuals (either to those who purchased via healthcare exchanges or those who were eligible for Medicare Advantage[c]). Government reimbursements per Medicare patient to cover healthcare had declined over time (see **Exhibit 5**); however, the 2010 Affordable Care Act (ACA) offered providers who were organized as accountable care organizations (ACOs)[d] a share of the cost savings generated in the delivery of care to Medicare patients, so long as minimum quality thresholds were met.

Key changes to the U.S. healthcare landscape over the decade prior had influenced healthcare providers like CHS and other healthcare stakeholders to revisit their care delivery models:

- **Fee-for-value instead of fee-for-service** After the ACA's passage, hospital compensation was determined in part by the quality of outcomes, rather than simply on a fee-for-service basis as before. Hospitals faced penalties for high readmission rates and hospital-acquired conditions, but could also receive financial rewards for exceeding clinical quality outcome or patient satisfaction benchmarks. Many healthcare providers sought to quickly build capabilities in analytics and measurement in order to track quality improvements, and to shift the organizational focus toward the continuous improvement of patient care.

- **Physician shortages** In the U.S., there were roughly 2.5 physicians per 1,000 people (versus an average of 3.3 per 1,000 among comparable OECD countries).[2] The ACA was expected to exacerbate the supply-demand shortfall in the future, since it increased the population covered by health insurance. In 2014 alone, nearly 32 million new people entered the healthcare system.[3] The Association of American Medical Colleges estimated that, by 2025, the U.S. would face a shortage of over 130,000 doctors.[4]

- **Digitization of healthcare** In 2011, the U.S. Centers for Medicare and Medicaid Services (CMS) established an incentive system for doctors' offices and hospitals to switch from paper to EMRs. Hospitals that served Medicare patients could receive up to a $2 million incentive for adopting EMRs.[5] Although patients were free to view and request corrections to the data in their EMRs, the platforms made it difficult for providers to extract and model the data held

[b] Medicare was the federal health insurance program offered to seniors aged 65 and older. Medicaid was offered to low-income individuals who were unable to obtain healthcare via the exchanges or an employer.

[c] Insurers offered Medicare Advantage plans to eligible patients who chose to receive their benefits via the insurer's network.

[d] Qualified ACOs agreed to be accountable for the overall care of their Medicare patients, obtain adequate participation of primary care physicians, create processes around evidence-based medicine, report on quality and costs, and coordinate care.

in the EMRs. In 2014, Google and Apple each announced healthcare dashboards that would aggregate data from wearable devices, including scales, running apps, and sleep trackers, into a consumer-friendly dashboard. Apple even partnered with several EMR companies to make medical records and lab results available to consumers on their iPhones via the single dashboard.

- **Shift to outpatient** In an effort to cut costs and increase access to care, providers encouraged patients to seek care via outpatient facilities, or even via virtual checkups, rather than at high-cost treatment locations like emergency departments (EDs). Outpatient care comprised 51% of health expenditures in the U.S., whereas the average among OECD countries was 33%.[6] In 2013, CHS chief executive Michael Tarwater observed: "More than 90% of our patient encounters now take place in a setting other than the bedside of an inpatient hospital room."[7]

- **New entrants** The shift to outpatient care led consumers to seek more convenient and inexpensive healthcare services. Retailers (including CVS, Walmart, Target, and Kroger) began opening healthcare clinics staffed by nurse practitioners in their stores as early as 2000. By 2014, there were 1,600 walk-in clinics in the U.S., and the number was expected to reach nearly 3,000 by 2015.[8] Cost of care at the clinics for three common illnesses averaged $110, versus $166 at doctors' offices and $570 in EDs.[9]

HIPAA Regulations

In 1996, the U.S. House of Representatives passed the Health Insurance Portability and Accountability Act (HIPAA). HIPAA provided for both the portability of employer-provided health insurance (which enabled an individual to keep the same health insurance between jobs) and the establishment of the first set of national security and confidentiality standards for patient health data.[10] The U.S. Department of Health and Human Services (HHS) established a privacy rule to protect individually identifiable patient data, while still enabling stakeholders to access the data needed to provide care. Data protected under HIPAA included physical or mental health conditions (including those that occurred in the past), healthcare provided, payments made for healthcare received, and demographic information that could be used to identify the individual (see **Exhibit 6** for examples).

Health plans (payers), healthcare providers, and healthcare "clearinghouses" (which included billing services, community health management information systems, value-added networks, and other business associates) were all subject to the privacy standards outlined in HIPAA. Healthcare organizations had to notify patients of their privacy rights (including acceptable use of personally identifiable information) and obtain signed authorization from patients for any use of individual data beyond treatment, payment, and healthcare operations.[11] Restrictions on data use could be waived if data were "de-identified," either by the formal assessment of a statistician to prove individual anonymity was retained, or by the removal of indicators used to identify the individual and his or her relatives, employer, or household members.[12] De-identified data became propriety to the company that held it.

HIPAA supported use of patient data to perform analysis necessary to make improvements to healthcare systems, including quality reviews, utilization reviews, and population reviews (often for a given condition, such as diabetes). Such information could be shared with other entities also subject to HIPAA, such as payers. Employers like CHS, who both provided healthcare and self-funded insurance to their employees, were not permitted to view their employees' disaggregated healthcare data; in addition, employee information collected through the human resources department was kept

separately from employee health data. Those who contravened the HIPAA privacy rule could be subject to civil and/or criminal charges and fines of over $1 million.[13]

Dickson Advanced Analytics (DA²)

Following CMC's designation as a teaching hospital in 1990, CHS established partnerships with 11 academic research centers. There was no medical school located in Charlotte at the time, so one of the independent centers was designated a branch of UNC. The Dickson Institute for Health Studies, as the center was known, provided education and training facilities to 300 residents, nurses, and graduate students. It partnered with UNC–Charlotte and UNC–Chapel Hill to provide health-data-focused projects to PhD candidates. The Dickson Institute initially focused on improving acute care quality, but the mission was later broadened to cover an array of healthcare projects under the leadership of Dr. Roger Ray, executive vice president and chief physician executive at CHS. Although the Dickson Institute conducted research, data analysis, and public reporting of key metrics for CHS, Ray noted that its activities did not influence the majority of day-to-day operations that occurred within the CHS network.

Beginning in the 2000s, CHS embarked on a visioning and process-development project to determine what data analytics capabilities would be integral to CHS's operations in the future. It determined it would need to develop a distributed data system and create a corporate data warehouse and decided to coalesce analytics personnel who were currently working in small silos throughout the organization to achieve the vision. CHS Information Services leadership anticipated that cost of data storage would plummet, based upon their experience implementing the EMR system at CHS in 2006, so the team decided to build generous data storage to support the new analytics team. Prior to CHS's adoption of EMR, most of the data it collected was financial data generated through transactions. The EMR rollout served as a proof-of-concept that patient data and financial data could be combined to provide decision support. With increasing computing power, CHS and other providers could collect, store, and model a variety of clinical data (including unstructured data) that it could not have assembled previously.

CHS hired consultants to advise the organization on the creation of a unified analytics group through the development of a high-level road map. Lovin was interviewed by the consultant group and asked to provide executive leadership for the initiative, and she recruited Dulin to help execute on CHS's vision of creating a unified, data-driven system. Dulin was trained in electrical and biomedical engineering and worked as a quality control specialist for a microchip manufacturer before attending medical school. At the time, there were many groups within CHS that handled analytics, but most were tied to a particular business, function, or geography with no integration. CHS decided to differentiate on the basis of its analytics capability and made investments to raise the analytics "IQ" of the organization. CHS leadership and others believed the system could move beyond its current analytics-related key performance indicators (KPIs) to include data in key decisions that would change patient care and save money over the long term. The new analytics group could have adopted a hybrid model structure wherein descriptive analysis linked to performance metrics was performed internally and more rigorous analytics were outsourced, but CHS instead chose to develop both its foundational descriptive analytics and more advanced predictive and prescriptive models in-house.

Creation of DA²

Dickson Advanced Analytics (DA²) was launched in 2011 with an annual budget of $14 million. It was initially composed of 70 people sourced from the disparate internal analytics groups that

preceded DA². Much of DA²'s capacity was devoted to providing tools to support CHS-affiliated hospitals in delivering best-in-class healthcare to patients, although, over time, DA² also developed analytical tools for evidence-based population health management, personalized patient care, and predictive modeling.

The success criterion for DA² was to improve outcomes, rather than increase the size of CHS. As Ray explained, "Healthcare is a massive cottage industry." He estimated that one-third of clinical work was "nonstandard," meaning that it diverged from a care plan and/or choices were made in the absence of evidence. Deploying analytics could help improve outcomes for work that was previously considered nonstandard. DA² also played an important role in the communication strategy, since improving quality of outcomes often required engaging the patient to change his or her behavior. Many at CHS believed the key to DA²'s success was a continuing commitment to build strong relationships with the physicians and nurses. The data DA² used was collected at many points of care through the CHS networks; in addition, any recommendations and tools derived from the data had to be implemented by the physicians (often by the clinical lead).

DA² sat outside of the organization's businesses, but still operated as a cost center. DA² reported to Lovin and the strategy function, rather than information services. As a result, Dulin and his team created a business plan for DA² to show its return on investment (ROI) over the long term, and prioritized projects of strategic importance to the organization. DA² was composed of five groups: "Applied Outcomes Research," "Data Services," "Client Services," "Project Management," and "Advanced Analytics." Compulsory reporting was one of DA²'s core responsibilities: most of the staff of 120, including 12 PhD-level analysts, worked on reports submitted to the government. Within DA², over time, a 15-person team dedicated to serving the medical group performed predictive work. A smaller research team worked to help measure the strength of the models and the interventions they delivered. Another DA² team studied cost analytics to measure the ROI of quality-increasing investments. The businesses focused on identifying revenue opportunities, and DA² helped to assess what each opportunity would be worth. Patient data could be used to support investment decisions, such as which surgical devices to purchase, since patient data contained information on the quality of outcomes (which DA² then combined with cost and device lifespan to assess ROI). One of Dulin's responsibilities was managing DA²'s internal customers, whose demand for analytics quickly outstripped the team's capacity. Many saw the potential for DA² to become an additional revenue stream by outsourcing its analytics services to third parties in the future.

Shortly after DA² launched, the team received more than twice as many requests as it had capacity to accept. DA² created an advisory board for issues related to effectiveness, priority setting, and other key focus areas. Then, CHS created a priority-setting process for developing predictive analytics: first, DA² conducted interviews with the clinical teams and an internal focus group (which was incorporated into the proposals for each project); then DA² determined each proposal's alignment with existing systems and CHS strategy, and balanced the resources the proposal required against those needed for DA² to conduct ongoing reporting and data warehouse management responsibilities. Finally, it assessed the projects against a matrix of criteria, including size, patient impact, mortality vs. quality-of-life improvements, speed of implementation, cost, and commercial viability. Included in the process, DA² would provide updates to the Clinical Integration Council (CIC), the highest physician leadership team.

DA² sought outside partners to improve the breadth and quality of its data. In 2013, CHS partnered with four healthcare systems and IBM to form the Data Alliance Collaborative (DAC), which focused on improving population health by creating scalable data models. The healthcare partners contributed data to a communal warehouse, which contained data from over 100 hospitals

and 1,600 non-acute care sites serving 28 million patients.[14] IBM provided the data infrastructure, which could incorporate clinical, claims, and financial data, to support the analytics.[15]

CHS used strategic partnerships to incorporate provider and payer data with consumer data into its predictive algorithms. Dulin believed that such data would give DA² additional insight into communities and patient populations, and provide indications for early interventions for potential problems beyond EMR data. The spending data, along with other inputs, were used to create a risk score for admitted patients, which were then distributed to doctors and other healthcare providers to reprioritize care delivery. This approach allowed the hospital system to focus limited resources on high-risk patients to improve their outcomes and their health status.

DA² and the Data Governance Committee

In 2012, CHS established a data governance committee, headed by Alicia Bowers, vice president of corporate privacy, and Michael Trumbore, assistant vice president of advanced analytics (and sponsored by Ray). The group included representatives from DA², clinical and translational research, information services, human resources, financial services, audit services, systems business, and the office of the general counsel. Members of the CHS institutional review board (IRB)[e] also had seats on the committee. Since CHS was a research organization, it followed the IRB standards to guide its handling of data. For example, one of the IRB privacy standards dealt with creating a geographically informed dataset and prevented disclosure of information if fewer than 50 people lived within a single census tract.

The data governance group was formed to protect, manage, and determine accountability for the data generated in the day-to-day operations of CHS. CHS recognized that the organization had a data strategy, whether or not it was made explicit. With the formation of the data governance group, it hoped to signal executive support for DA² and facilitate engagement with the information services, clinical, and business groups. The group met monthly to:

- Create data governance policies.
- Prioritize data governance initiatives (including pilot programs).
- Define data governance policies, standards, processes, metrics, and principles.
- Communicate the vision and activities of the group to the broad CHS organization.
- Address the governance structure, data access, and data quality.

A key initiative of the advisory group was the appointment of "domain owners," who were responsible for upholding governance standards for the data and business processes in a given domain. Domains referred to clusters of data that were organized around CHS businesses. For example, the research domain might contain documentation of patient consent, IRB compliance, and grant information, whereas the patient domain could contain EMR information and treatment plans. The domain owners led multifunctional teams composed of process owners, data stewards, and project managers, as well as representatives from information services and data governance who were responsible for tracking performance against KPIs, data quality, and compliance with internal data governance policies. The domain owners reported to the Strategic Governance Council, chaired by Dulin, who ultimately reported to the Executive Governance Council, led by Lovin (see **Exhibit 7** for an organization chart).

[e] The IRB was a committee formed to protect the welfare of human subjects involved in research, including maintaining the subjects' privacy. All IRBs were registered with the Office for Human Research Protections, a division of the U.S. Department of Health and Human Services.

DA² in 2014

By November 2014, DA² had achieved three key results: it collected and handled vast amounts of data efficiently; it created a data governance structure; and it helped shift the organization away from an anecdotal culture to an evidence-based one. The year prior, DA² had spent $5 million[16] to create its enterprise data warehouse (EDW). The EDW initially contained 10 terabytes of data derived from the system's 1.5 petabytes of data, which doubled in size by 2015. The data warehouse incorporated clinical, billing, and claims data, which enabled DA² to create models including hundreds of different patient variables. In 2014, DA² had a pipeline of nearly a dozen predictive risk models in development and consistently more requests from the organization than it had capacity to accept. Lovin said, "We went from having no DA² to wanting to check their opinion on everything." DA² had made progress toward changing the culture of CHS to be evidence-based and data-driven; however, its success meant DA²'s capacity was strained by demand for its analytics services. DA² began to provide the business lines with tools and education so that some analytics could be performed independently and DA² could reserve capacity for more complex questions.

Key DA² Pilots

In 2014, the three ongoing strategic priorities for DA² were to predict health needs; continually enhance patient outcomes; and drive transformative solutions to address community health issues. By that time, DA² had launched a number of successful pilots covering a variety of medical conditions, geographies, and functional capabilities.

Mapping underserved communities In 2009, the Dickson Institute launched a project to reduce unnecessary emergency department (ED) utilization in Charlotte by identifying areas underserved by primary care facilities. The project leveraged descriptive data and clinical data from local primary care and ED facilities in Charlotte to find the best variables to indicate poor access to primary care. Over 367,000 clinical records were sourced from all 2007 patient visits to CHS primary care and ED facilities. Data that did not contain the patient's address, or from patients who lived outside of the county, was excluded, which left a dataset of 187,000 ED visits and 50,000 primary care visits, as well as patient insurance status,[f] to be used in the model.[17] For descriptive data, the team used U.S. Census data at a census tract level.[g]

After mapping and testing multiple variables, the team selected five for use in the primary care access model: population density, median household income, the uninsured/Medicaid population, the incidence of ED utilization for primary care–treatable or preventable conditions, and the proportion of the population that currently used primary care facilities.[18] Equal weight was given to each variable in the model, although the use of primary care facilities was given an inverse, but still equal, weight (see **Exhibit 8** for variables). The numeric value of each variable was calculated for each census tract before being combined to create the single measure of need for primary care facilities in that area. Census tracts with values greater than one standard deviation above the mean were highlighted as high-need areas (see **Exhibit 9** for map).

The geo-tagging technique was relatively inexpensive and could quickly identify community candidates for additional primary care clinics. The U.S. Census data was free to the public, and, once all data was geocoded, the process of building a new model with weighted attributes took only a few

[f] Patient insurance status contained five categories: Medicare, Medicaid, commercial, uninsured, and other.

[g] Census tracts were geographic regions defined by the U.S. Census Bureau that contained between 1,200 and 8,000 people. Census tracts were typically slightly smaller than zip codes.

hours. The team believed a similar approach could be used to anticipate localized future demand for healthcare professionals, to develop interventions to improve access to primary care facilities, to provide data to support policy decisions regarding healthcare initiatives, and to measure the impact of interventions designed to improve healthcare access.

Reducing readmissions The Readmission Predictive Risk Model was launched by DA² in 2013 to help the clinical teams in CHS hospitals identify high-risk patients. DA² developed an algorithm that calculated a "readmission risk score" for each admitted patient. The score was modeled from data on the thousands of patients that had been discharged from one of the CHS facilities in the prior two years. Out of 600 variables in the data, DA² found 40 to be highly predictive of readmission, including history of ED visits, sodium levels, language, and late-stage renal disease.[19] Patients who were identified as high risk for readmission within 30 days of discharge received extra focus from clinicians while still in the hospital. The model had an accuracy rate of 79% in predicting a patient's risk of readmission within 30 days of discharge. In addition, the model clustered patients into one of five segments (see **Exhibit 10**), each of which possessed a unique set of guidelines for transition planning (which were given to the discharge care manager). The discharge care manager could then select appropriate interventions, such as scheduling follow-up visits to the patient's home, helping patients manage their medications, and connecting them with dietitians, trainers, and/or coaches to provide appropriate follow-up care.

Advanced Illness Management CHS created an Advanced Illness Management Group (AIM), which reported to Ray, to help patients with complex medical conditions avoid hospital stays. Those patients carried a higher risk of hospital readmission, so the program offered access to a team of experts who helped the patients better understand their health conditions, symptoms, medications, and lifestyle choices in order to empower them to manage their own health and reduce unnecessary ED visits and hospitalizations. Eligible patients had at least two chronic conditions, had visited the ED or hospital more than twice over the last six months, took multiple medications to treat the same condition, and were not actively involved in another care management or intensive health program.

The first AIM cohort included 25 patients who collectively visited the hospital 96 times (they had visited the ED 41 times and were hospitalized 55 times) in the six months before the start of the program in 2014. The multidisciplinary AIM team included licensed clinical social workers, nurse practitioners, licensed practical nurses, and registered nurses. For each patient, the team assessed the unmet educational, psychosocial, and resource needs, and created a care plan in conjunction with the physician's medical plan. The team was in frequent contact with patients to monitor changes in health status, social circumstances, and/or psychosocial needs; to answer questions regarding medications or medical jargon; to discuss care options before going to the ED; and to remind patients of upcoming doctor's appointments. In select cases, licensed practical nurses attended the appointments with the patients. Patients in the first cohort experienced less pain, improved quality of care, and increased satisfaction, while also incurring lower costs to the healthcare system. The patients collectively visited the hospital only 33 times in the six months following the start of AIM. Due to the initial success of the AIM program, CHS enrolled additional patients in cohorts two and three.

Patient segmentation model In 2014, CHS reviewed the data of 2.2 million active patients who received care within the system and collected 2,000 data points per patient, including clinical data, medication compliance, education attainment, socioeconomic factors, and consumer spending profiles (DA² hoped to one day add genetic data and data generated by wearables). DA² created a segmentation model that grouped patients into one of seven distinct segments (e.g., "high risk of cancer"), so that patients in each group could receive care and communications tailored to their

specific needs. Within each segment, DA² selected a subgroup from which to gather qualitative data on segment-specific lifestyle and healthcare needs. The qualitative data in turn influenced the recommendations for the communication plans for the sufferers of various disease groups within each segment (a process managed by the AIM group, which partnered with care managers, social workers, pharmacists, and rehabilitative and palliative care centers).

The benefits to CHS were twofold: segmentation helped clinicians to identify high-risk patients quickly and help them change harmful behaviors; segmentation also helped CHS to estimate the expected cost of providing care to each segment and influenced how CHS bid on new business contracts with healthcare payers. Providers like CHS were often at a disadvantage when negotiating with payers, since the payers frequently had more information on the patients than the providers, who often lacked well-developed analytics capabilities. Since CHS acted as a payer for its own employees, it was aware of the types and quality of data the payers possessed. Trumbore believed that the CHS possessed better data than the average payer, as payers could only see what happened (e.g., claims data), rather than the clinical treatment process. Over time, CHS would use the insights gleaned from the segment analysis to optimize its care delivery model.

Key Challenges Ahead for DA²

As Dulin and his team prepared their strategic plan for the next three years, he pondered which of the existing pilots might be extended to different yet related issues without requiring the design and implementation of an entirely new model. The internal demand for DA²'s services could fill its current capacity several times over. CHS identified many opportunities for DA² to reduce waste while also improving outcomes, but recognized the need to satisfy as many internal constituents as possible. CHS leadership was interested in exploring external business opportunities that could potentially turn DA² into a source of profit for CHS, particularly given the mounting investments DA² had received for its technological infrastructure. However, high internal demands for DA²'s services constrained Dulin's ability to test DA²'s capabilities in the external marketplace. Another key focus for DA² was ensuring insights translated into action through the creation of user-friendly reports, and ultimately, consistent care plans and sets of orders to follow for patients with a given condition. Engaging with clinicians to ensure that data from the predictive models improved their workflow would be a core focus of DA² for years to come.

Exhibit 1 CHS Summary Financials, 2013

	Dollar Total (million)	Percentage of Total
Revenues		
Tertiary & Acute Care Services	$5,832	68%
Continuing Care Services	$293	4%
Specialty Services	$53	1%
Physicians' Services	$1,487	18%
Other Services	$225	3%
Non-Operating Activities	$469	6%
Total Revenues	$8,358	100%
Expenses		
Wages, Salaries & Benefits	$4,616	55%
Materials, Supplies & Other	$2,615	31%
Depreciation & Amortization	$454	5%
Financing Costs	$125	2%
Funding for Facilities, Equipment & Programs	$547	7%
Total Expenses	$8,358	100%

Source: Company documents.

Exhibit 2 CHS Charitable Expenditures, 2013

Charitable Expenditures	$, million
Cost of financial assistance to uninsured patients	$324
Bad debt costs by patients who do not pay for services	$290
Losses incurred by serving Medicare patients[a]	$563
Losses incurred by serving Medicaid patients	$161
Cost of community-building activities and other services	$56
Cost of medical education, research, and cash and in-kind contributions to charities	$146
Total value of uncompensated care and other community benefits	$1,540

Source: Company documents.

[a] Medicare and Medicaid offered fixed compensation per recipient, which occasionally fell short of the actual cost of care; hospitals were not permitted to refuse care to these patients.

Exhibit 3 CHS Strategic Priorities, 2014

Strategic Priority	Details
Quality & Patient Experience	Design a customer relationship management tool; increase health literacy; improve critical and diabetes care; improve clinical outcomes via collaboration software.
Integrated System of Care	Deploy the CHS care management platform; manage population health; deploy virtual care; transform service lines, continuing care, community health and point of care.
Strategic Growth	Deliver competitive, consumer-facing retail services; commercialize existing CHS services; develop payer/risk strategies with payers; deliver best-in-class specialty care.
Transformative Operations	Improve processes to reduce patient wait times; share and implement best practices across the organization; put the patient first in operational decisions; leverage engaged workforce.

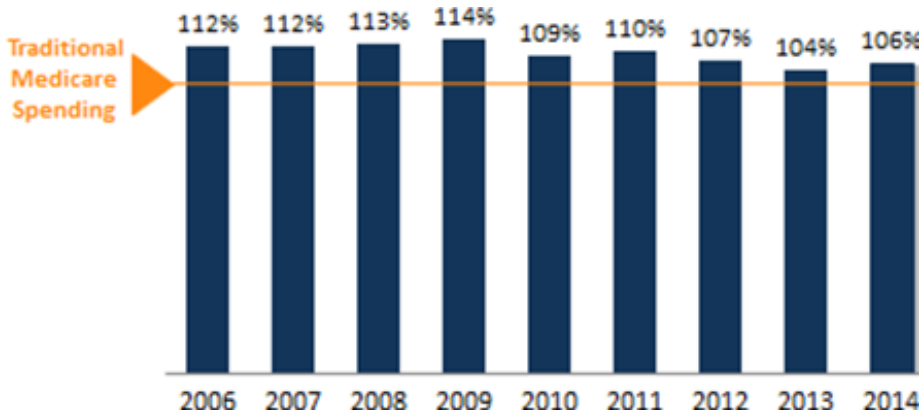
Source: Company documents.

Exhibit 4 CHS Strategic Performance Measures, 2014

Performance Measures	Metrics
Quality & Patient Experience	Inpatient mortality; breast cancer screenings; physician satisfaction; patient likelihood to recommend; patient safety score; diabetes treatment outcomes; appropriate care score (for both ambulatory and acute care).
Integrated System of Care	Readmission rate; CHS/payer collaboration performance; progress against integrated system of care goals; Medicare spend per beneficiary; CHS medical plan performance.
Strategic Growth	Actively managed primary care patients; population share; commercial/managed care population; use rates (versus industry benchmarks); evidence-based screening volumes; commercialized products or services.
Transformative Operations	Average length of stay; emergency department transformation score; operating cash flow margin; productivity improvement; revenue cycle improvement; process enhancement product standardization savings and speed.
Teammate Engagement	Commitment indicator score (percentile ranking)
Community Benefit	Number of individuals screened for pre-diabetes; hours of community service.

Source: Company documents.

Exhibit 5 Medicare Advantage Payments as a Percentage of Traditional Medicare, 2006–2014



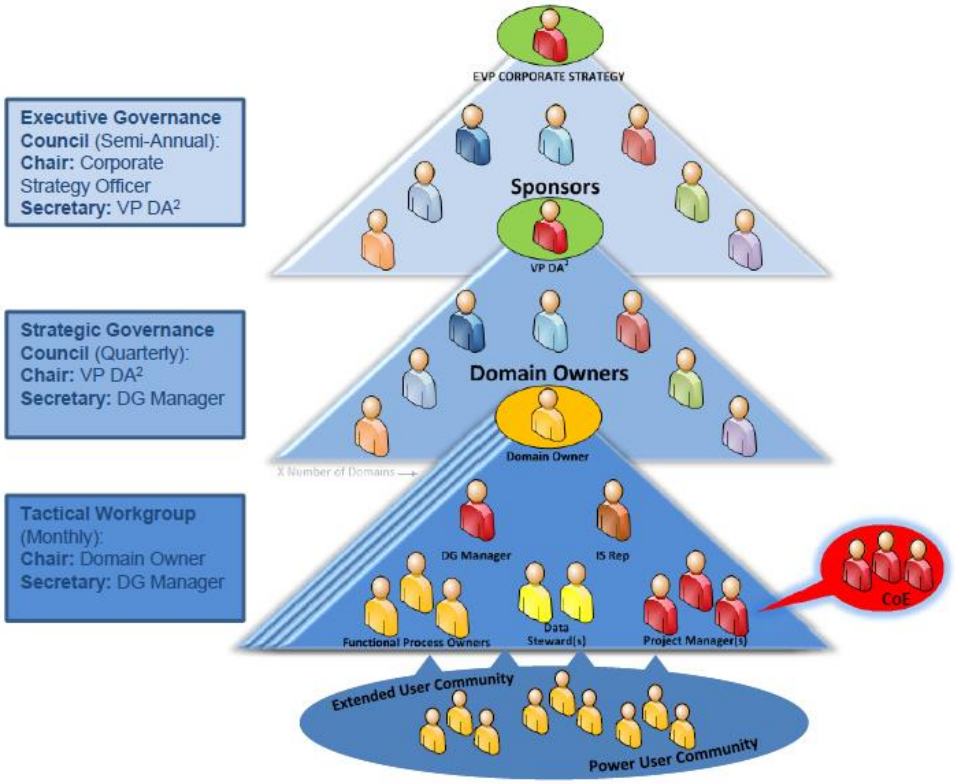
Source: "Medicare at a Glance," Kaiser Family Foundation, September 2, 2014, http://www.cdc.gov/obesity/data/adult.html, accessed October 2014.

Exhibit 6 Personally Identifiable Data Protected under HIPAA, 2014

Protected Personal Data Types	
Names	Account numbers
Addresses (including zip code)	Certificate/License numbers
Dates (birth, admission, discharge, death)	Vehicle identifiers and serial numbers (including license plate)
Telephone numbers	Device identifiers and serial numbers
Fax numbers	Web Universal Resource Locators (URLs)
E-mail addresses	Internet Protocol (IP) addresses
Social security numbers	Biometric identifiers, including finger and voice prints
Medical record numbers	Full-face photographic images and any comparable images
Health plan beneficiary numbers	Any other unique identifying number, characteristic, or code

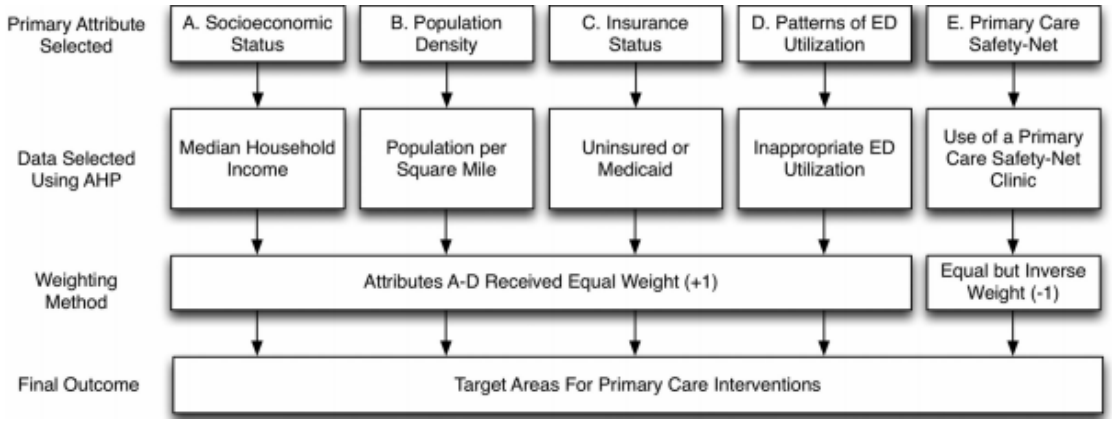
Source: Adapted from "HIPAA Background," Office of Corporate Compliance, University of Chicago Medical Center, February 2010, http://hipaa.bsd.uchicago.edu/background.html, accessed February 2015.

Exhibit 7 Data Governance Committee Organizational Chart, 2014



Source: Company documents.

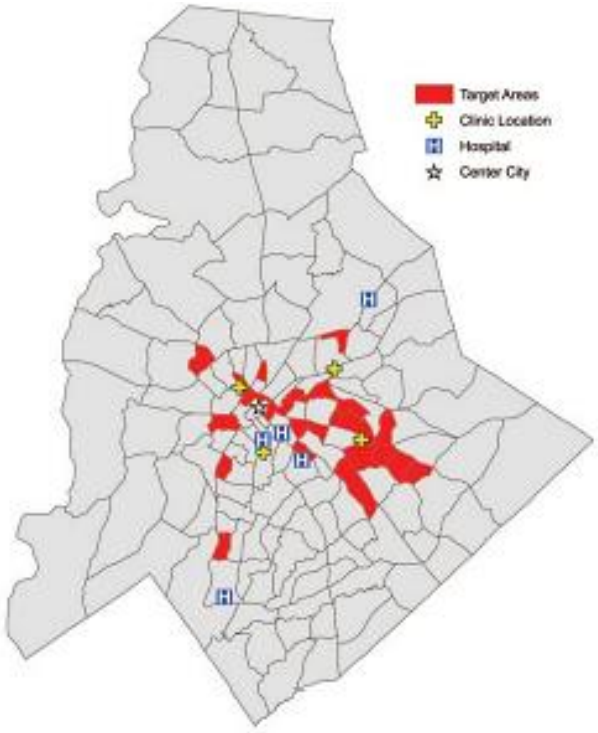
Exhibit 8 Variable Definition Process for the Primary Care Access Model,[a] 2013



Source: Dulin, Michael F., Thomas M. Ludden, Hazel Tapp, Heather A. Smith, Brisa Urquieta de Hernandez, Joshua Blackwell, and Owen J. Furuseth. "Geographic information systems (GIS) demonstrating primary care needs for a transitioning Hispanic community." The *Journal of the American Board of Family Medicine* 23, no. 1 (2010): 109–120. Reproduced by permission of the American Board of Family Medicine.

[a] ED referred to emergency departments; AHP referred to analytic hierarchical process.

Exhibit 9 Map of High-Need Areas in Charlotte Produced by the Primary Care Access Model, 2013



Source: Dulin, Michael F., Thomas M. Ludden, Hazel Tapp, Heather A. Smith, Brisa Urquieta de Hernandez, Joshua Blackwell, and Owen J. Furuseth. "Geographic information systems (GIS) demonstrating primary care needs for a transitioning Hispanic community." The *Journal of the American Board of Family Medicine* 23, no. 1 (2010): 109–120. Reproduced by permission of the American Board of Family Medicine.

Exhibit 10 Population Segments of the Readmissions Model, 2013

Segments	Low Risk	Medium Risk	High Risk	Very High Risk	Total
Insured Healthy Adult	14.4%	10.9%	6.0%	4.2%	35.5%
Medicaid Pediatric	4.1%	2.5%	1.2%	0.4%	8.2%
Medicare Independent	5.1%	6.6%	6.1%	5.1%	22.9%
Medicare with frequent visits	0.8%	2.7%	5.6%	5.2%	14.2%
Middle age with frequent visits	0.6%	2.3%	6.0%	10.3%	19.1%
Total	25%	25%	25%	25%	100%

Source: Company documents.

Endnotes

[1] "Health Expenditure—OECD Health Statistics 2014," OECD iLibrary, http://www.oecd.org/els/health-systems/health-expenditure.htm, accessed February 2015.

[2] "U.S. Health Care Resources Compared to Other Countries Slideshow," Kaiser Family Foundation, http://kff.org/slideshow/u-s-health-care-resources-compared-to-other-countries-slideshow/, accessed February 2015.

[3] "GME Funding: How to Fix the Doctor Shortage," Association of American Medical Colleges, https://www.aamc.org/advocacy/campaigns_and_coalitions/fixdocshortage/, accessed February 2015.

[4] "GME Funding: How to Fix the Doctor Shortage," Association of American Medical Colleges.

[5] "HER Incentives & Certification," HealthIT.gov, January 15, 2013, http://www.healthit.gov/providers-professionals/ehr-incentive-programs, accessed February 2015.

[6] OECD, "Health at a Glance 2013: OECD Indicators," OECD Publishing, 2013, http://dx.doi.org/10.1787/health_glance-2013-en, accessed February 2015.

[7] Company documents.

[8] Martha Hamilton, "Why walk-in health care is a fast-growing profit center for retail chains," *Washington Post*, April 4, 2014, http://www.washingtonpost.com/business/why-walk-in-health-care-is-a-fast-growing-profit-center-for-retail-chains/2014/04/04/a05f7cf4-b9c2-11e3-96ae-f2c36d2b1245_story.html, accessed February 2015.

[9] Hamilton, "Why walk-in health care is a fast-growing profit center for retail chains."

[10] "Summary of the HIPAA Privacy Rule," U.S. Department of Health and Human Services, May 2003, http://www.hhs.gov/ocr/privacy/hipaa/understanding/summary/privacysummary.pdf, accessed February 2015.

[11] "HIPAA Background," Office of Corporate Compliance, University of Chicago Medical Center, February 2010, http://hipaa.bsd.uchicago.edu/background.html, accessed February 2015.

[12] "Summary of the HIPAA Privacy Rule," U.S. Department of Health and Human Services.

[13] "HIPAA Background," Office of Corporate Compliance, University of Chicago Medical Center.

[14] Ken Terry, "Healthcare Collaborative, IBM Partner On Big Data Platform," *Information Week*, June 18, 2013, http://www.informationweek.com/healthcare/clinical-information-systems/healthcare-collaborative-ibm-partner-on-big-data-platform/d/d-id/1110419?, accessed February 2014.

[15] Terry, "Healthcare Collaborative, IBM Partner On Big Data Platform."

[16] Joe Carlson, "Carolinas centralizes data analytics to reduce readmissions and redesign care," *Modern Healthcare*, December 9, 2013, via Factiva, accessed October 2014.

[17] Michael F. Dulin, Thomas M. Ludden, Hazel Tapp, Heather A. Smith, Brisa Urquieta de Hernandez, Joshua Blackwell, and Owen J. Furuseth, "Geographic information systems (GIS) demonstrating primary care needs for a transitioning Hispanic community," *Journal of the American Board of Family Medicine* 23, no. 1 (2010): 109–120.

[18] Dulin et al., "Geographic information systems (GIS)."

[19] Carlson, "Carolinas centralizes data analytics."