Chapter 4
Quality Improvement of Healthcare Services Through Data Analytics Processes

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ABSTRACT

Improving quality of care is one of the priorities of policymakers in the U.S. While the spending on quality of care in the U.S. is the highest among all the developed nations, the desired health outcomes achieved have been below many of them. The largest portion of personal health care spending in 2019 went toward hospital care (37.2%), which was followed by physician and clinical services (24.1%). In this chapter, the authors focus on these direct care services, specifically explaining how hospitals and clinics can improve health and financial outcomes using data analytics. Specifically, building on CRISP-DM, a data mining process model, the authors explain the healthcare data analytics processes for hospitals and clinics to improve quality and financial performance.

1. INTRODUCTION

The World Health Organization defines quality of care as the "*degree to which health services for individuals and populations increase the likelihood of desired health outcomes.*" Improving quality of care is one of the priorities of policymakers in the U.S. While the spending on quality of care in the U.S. is the highest among all the developed nations, the U.S was ranked poorly in several measures of wellbeing or desired health outcomes (cms.gov, 2023). For example, health spending accounted for 18.3 percent of the nation's Gross Domestic Product, while life expectancy is 77 (85 in Japan, the highest) and obesity hits an all-time high (40% in adults) (cms.gov, 2023). To address these public concerns, the U.S. healthcare system extensively supports initiatives and policies to reduce the cost and improve the quality of

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care, such as population health and prevention, value-based care, patient-centered care, electronic health records and price transparency (Kocher et al., 2010; Afrizal et al., 2019; Hajian et al., 2023).

In this chapter, we focus on direct care services, specifically *how hospitals and clinics can improve health and financial outcomes using data analytics*. Two main groups of institutions contribute to the quality of care in the U.S.: those that provide direct care to patients (such as hospitals, clinics, and treatment centers), and those that support the care of individuals through products and services (such as pharmaceuticals, insurance, and population health organizations). The largest portion of personal health care spending in 2019 went toward hospital care (37.2%), which was followed by physician and clinical services (24.1%) (cdc.gov, 2023). The main function of hospitals is to provide medical treatment and care to patients with illnesses, injuries, or other health conditions. Hospitals also offer emergency care, diagnostic testing, surgery, rehabilitation, and inpatient and outpatient care. Some large size hospitals serve as a center for research and education, providing opportunities for medical professionals to advance their knowledge and skills. Additionally, hospitals play a crucial role in public health, providing vaccinations and disease control measures, and serving as a resource for health information and education for the community.

While hospitals and clinics account for a significant portion of the healthcare spending, their profit margins are narrow. Some hospitals, particularly large academic medical centers, may operate at a loss or with very thin margins due to the high cost of providing complex medical services, conducting research, and training medical professionals. On the other hand, smaller, community hospitals or specialized facilities may be more profitable due to their lower overhead costs and more favorable payer mix. Large or small, all hospitals and clinics are price-takers, meaning they do not have the power to influence the market price of their services. In other words, hospitals accept the prevailing market price often set by the government and insurers and cannot negotiate a higher or lower price for their services.

Since hospitals cannot control prices, they aim to minimize their cost as well as maximize their revenue from insurers. Particularly, in recent years, the hospitals have faced financial pressures, including increasing competition, declining reimbursement rates, and rising costs for labor, supplies, and technology. Many hospitals have sought to reduce costs and improve efficiency, while also exploring new revenue streams, such as outpatient services, telemedicine, and partnerships with other healthcare providers. Ultimately, the profitability of hospitals is a complex and dynamic issue that is influenced by a range of economic, regulatory, and demographic factors. With the Affordable Care Act, hospital reimbursements from insurers are closely tied to their quality performance. Hospitals are financially penalized due to their relatively low-quality performance (Barnes et al., 2018).

Since hospitals' financial performance is closely tied to their quality performance, hospitals put extensive efforts for continuous improvement. All continuous improvement models highlight the vital role of data analytics. For example, one of the earliest of these models is the Plan-Do-Check-Act (PDCA) cycle (Taylor et al., 2014). In particular, the PDCA cycle is an iterative data-driven problem-solving technique that was first developed by American physicist Walter Shewhart in the 1920s. In the 1950s, Edwards Deming popularized the technique and named the cycle the "Shewhart" Cycle. PDCA cycle starts with "*planning*", which is defining the research questions. The next stage is "*do*", which involves the data collection. The next one is "*check*", which is the analysis of the data. The cycle finishes with "*act*", which the service organizations identify and implement the solution.

Since the 80s, computer scientists in the artificial intelligence and machine learning field have been applying algorithms on clinical data to assist physicians make diagnoses, and to reduce healthcare costs. Since then, multiple data analytics process models have been proposed to provide a detailed explana-