Discrete Event Simulation and Real Time Locating Systems: Technology Integration for Process Improvement

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ABSTRACT

The Veteran’s Health Administration (VHA) is the largest integrated health care system in the United States, forming the arm of the Department of Veterans Affairs (VA) that delivers medical services. From a troubled past, the VHA today is regarded as a model for healthcare transformation. The VA has evaluated and adopted a variety of cutting-edge approaches to foster greater efficiency and effectiveness in healthcare delivery as part of their systems redesign initiative. This paper discusses the integration of two health care analysis platforms: Discrete Event Simulation (DES), and Real Time Locating systems (RTLS) presenting examples of work done at the St. Louis VA Medical Center. Use of RTLS data for generation and validation of DES models is detailed, with prescriptive discussion of methodologies. The authors recommend the careful consideration of these relatively new approaches which show promise in assisting systems redesign initiatives across the health care spectrum.

Keywords: Discrete Event Simulation, Health Care, Optimization, Radio-Frequency Identification, Technology Integration

INTRODUCTION

The Veterans Health Administration (VA) is the department within the United States federal government created to serve the needs of America’s veterans by providing primary care, specialized care, and related medical and social support. Meeting this challenging responsibility in a resource constrained environment requires that the VA seek innovative and emerging methods and technologies. The VA, as a single-payer, single-provider system, is unique in the U.S.
health system. It has the ability to act as a proving ground for standardized health care delivery, and the widespread adoption of effective means of quality assurance. The VA has embraced the concept of systems redesign advanced in the seminal Institute of Medicine (IOM) publication “Crossing the Quality Chasm” (Institute of Medicine, 2001) This paper presents our experience in implementing elements systems redesign through novel approaches within an academic tertiary care VA medical center. We specifically examine the use of two tools---Discrete Event Simulation (DES) and Real Time Locating systems (RTLS) in concert for patient flow analysis in health care delivery. These approaches individually have shown promise in improving health systems. It is only now that concerted efforts are beginning to integrate these technologies. The St. Louis Veterans Administration Medical Center (STLVA) recently deployed an RTLS in the Eye Clinic and the Operating Rooms which marks a first for the VA, nationally. This system is employed along with DES to improve processes and identify opportunities for systems redesign. In concert, these technologies allow us to identify, evaluate, and ameliorate obstacles to health care delivery.

BACKGROUND

Systems Redesign

Systems Redesign is a Veterans Health Administration initiative, headed by the National Systems Redesign Program Office and the National Systems Redesign Steering Committee, engaged in organizational transformation for the delivery of health care within the VA. The fundamental goal of Systems Redesign is to deploy quality improvement initiatives in order to continuously elevate the standard of performance at VHA facilities (Davies, 2007). This is accomplished in several ways, including the comparison of high functioning facilities to low functioning facilities, grassroots initiatives like the VHA Innovations Campaign, and the adoption of sophisticated technological and analytical approaches. The use of queueing theory and analytical practices like Six Sigma and Lean Programming are popular in the health care field, and indeed in the VA specifically (Eldridge et al., 2006). These are effective tools for gathering the ‘low hanging fruit’ in systems efficiency. Among the technological approaches to systems improvement is the use of discrete event simulation (DES), informed by data generated by real time locator systems (RTLS) which we discuss in the upcoming sections.

The systems redesign program in the VA has been spearheaded by the Quality Enhancement Research Initiative (QUERI). The fundamental goal of QUERI is to foster and support collaboration for implementation and systems redesign between researchers and those who manage and provide medical care. The transformation of the Veterans Health Administration using the principles of systems redesign is detailed by Kizer and Dudley (2009). These collaborations among the principle stakeholders in health reform are resulting in positive results in medicine, such as in areas of colorectal cancer (Jackson et al., 2010), psychiatry (Bhatia & Fernandes, 2008), and also in policy and delivery (Evans et al., 2006; Atkins et al., 2010; Wang et al., 2006).

Discrete Event Simulation

Discrete Event Simulation is a graphical, computer-based, simulation tool applicable to the analysis of systems which are characterized by elements changing states at particular instances in time (Pooch & Wall, 1993). These are called ‘events.’ In the realm of health care delivery, events represent the state changes in a patient, physician, operating room, or other object during the course of the delivery and receipt of medical care. Medical care is delivered in a hybrid environment, meaning that some states change in a continuous fashion such as a patient’s blood pressure over time, and others change in discrete jumps, such as whether a patient has received a medication or not. However, when modeling these systems in computer simulation, all events are modeled as discrete events because of the digital nature of the computer. Continuous changes are represented as very small discrete events that occur very close
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