QUALITY ASSURANCE IN HEALTHCARE: A THREE-STAGE VALUE-ADDED SYSTEMS FRAMEWORK

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ABSTRACT

The goal of this research is to focus on quality assurance in healthcare as a multi-level concept and show how systems can be used for holistic quality assurance. We do so by providing a theoretical three-stage value-added framework to study the impact of Information systems on healthcare quality assurance.

Keywords: Operations, Quality Assurance, Healthcare, Information Systems, Prescription ordering

INTRODUCTION

The recent focus on the healthcare industry has brought to light drawbacks and inconsistencies in healthcare services that have negative outcomes ranging from inconvenience to fatalities. According to the CIA World Factbook, at a life expectancy of 78.49 years, the United States ranks 50th in the world. The same source ranked the United States 174th of 222 in the world for infant mortality rate. Between 1997 and 2003, preventable deaths declined slower in the United States than in 18 other industrialized nations (Nolte and McKee, 2008). A 2008 study found that 101,000 deaths per year in the U.S. could have been prevented had the healthcare system been as effective as that of France, Japan, or Australia (Dunham, 2008). In 2000, The World Health Organization (WHO) ranked the U.S. healthcare system 37th in overall performance and 72nd by overall level of health among 191 member nations included in the study (WHO, 2000).

The aggressive push to improve healthcare services, particularly in the area of quality assurance (QA), is hence no surprise. Initiatives at the government, sectoral, community, and institutional levels are aimed at enhancing quality assurance in healthcare. These initiatives often involve considerable financial outlays, and substantial efforts on behalf of all stakeholders involved. Despite the focus on improving quality, research has failed to find evidence of the impact of quality improvement measures on healthcare costs (Rauh et al., 2011). Hence there is a critical need to study how quality assurance initiatives can be successful, and can result in maximum value derived for the stakeholders.

One category of initiatives involves the implementation and institutionalization of information systems (IS) in healthcare services. These include initiatives such as the electronic medical

health record (EMHR) programs, medical expert systems' use (Bunn, 2006). In this landscape of the plethora of IS programs, it is important to make sense of how they add value to the quality assurance goals in healthcare. We draw on the framework of levels of value added by IS, proposed by Valacich and Schneider (2010), to characterize and suggest ways in which an IS plays a role in quality assurance. Specifically, the framework conceptualizes three different roles that IS can play – automation, information, and strategizing – each corresponding to a certain level of value added.

We describe the medication administration process (MAP), which encompasses the ordering and dispensing of medications to patients. We demonstrate how an information system called computerized physician order entry (CPOE) provides quality assurance at different levels in MAP. We primarily find evidence of automation support by CPOE, and suggest ways in which it can be used for informating and strategizing to derive maximum value for quality assurance.

The goal of this research is to focus on quality assurance as a multi-level concept and show how systems can be used for QA at different levels. The study contributes to research in healthcare by providing a framework for looking at different levels at which IS can support QA and calling for practitioners and researchers to focus not just on automation, but also information and strategizing benefits that can be derived from IS.

LITERATURE REVIEW

In this section we first provide a definition of quality assurance in healthcare with a focus on pharmacy. We then elaborate on a theoretical framework of value-added characteristics of information systems. In the next section, we discuss the role of IS in healthcare quality assurance and how our theoretical framework is applied to study quality assurance through IS in healthcare.

Quality Assurance in Healthcare

The term Quality Assurance comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service (American Society for Quality). Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system, which provide a means to control the quality of the material, structure, component, or system to predetermined requirements (Berwick, 1990; Donabedian and Bashur, 2002). Quality assurance in the field of healthcare encompasses activities and programs intended to assure or improve the quality of care in either a defined medical setting or a program (Perides, 2002). The concept includes the assessment or evaluation of the quality of care; identification of problems or shortcomings in the delivery of care; designing activities to overcome these deficiencies; and follow-up monitoring to ensure effectiveness of corrective steps.

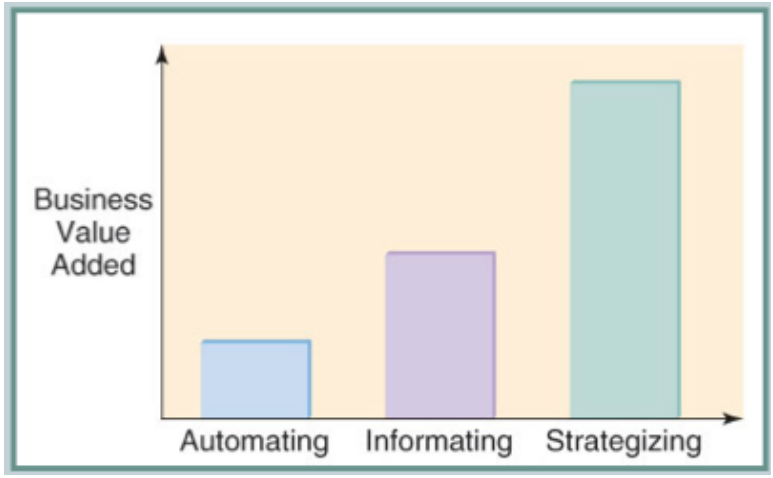
The current growth in the technology and knowledge of healthcare is faster than at any time in history. These advances have brought with them a separation between physicians, hospitals, ambulatory clinics, and insurance companies. This separation and lack of communication is

causing a drop in the quality of care that many patients receive. In order to improve the quality of healthcare we need to not only implement traditional practices such as focus on education, professional integrity and ethical performance behavior, but also use information systems to enhance quality and provide consistency in healthcare practice. Of the multiple criteria for the quality of care laid down by The Institute of Medicine (IOM), criteria such as measurement of quality of care, decreasing costs and increasing access to healthcare, are a few that may benefit from the use of information systems.

One specific area that has room for improvement in quality is that of pharmacy. There are high margins of error and inconsistencies in pharmaceutical care, often as a result of miscommunication and separation between doctors and pharmacists (Spry, Lawley, 2005). Drugs are often unlicensed or used off-label, suitable formulations or appropriate strengths are lacking, and drugs have to be extemporaneously prepared, liquids and injections diluted, and tablets split. These factors increase the likelihood of medication errors and may lead to reduction in drug effectiveness, or in extreme cases, fatalities. Reliance on paper-based reporting and record keeping results in loss of time and efficiencies. All these challenges provide unique opportunities for pharmacists to improve the quality of care for patients.

Levels of support of Information Systems

IS can be used in different ways to add value to an organization (Valacich and Schneider, 2010), by automating, informating, and strategizing. When used for automating, tasks can be completed faster, cheaper, more accurately, and with greater consistency. When used for informating, information systems can be used to learn about processes, improve processes, and support organizational learning. When used for strategizing, IS can be used to gain or sustain competitive advantage by turning benefits of automating and informating into strategic advantage. As shown in the figure below, different levels of value are added with each use of IS. While automating provides the least business value, it should be noted that it is an essential first step to informating and strategizing. Similarly, strategizing is possible after informating is achieved.



Framework of Value-Added by IS From Valacich and Schneider (2010)

INFORMATION SYSTEMS SUPPORT IN HEALTHCARE QUALITY ASSURANCE

The levels of value added by IS have a direct bearing in QA processes. Through automation, accuracy and consistency of processes is improved. Through information, processes can be streamlined and made more effective. Through strategizing, processes may be changed to develop competencies that were not possible with older processes. While the ultimate goal of QA in healthcare is to arrive at best practices that engender confidence in healthcare services, i.e. strategize, the framework informs us that this is not possible without first automating and informating. The framework also predicts highest returns on value added to QA effort when such strategizing occurs.

We next describe the medication administration process (MAP), which encompasses the ordering and dispensing of medications to patients. We then demonstrate how an information system called CPOE provides quality assurance at different levels in MAP. We primarily find evidence of automation support by CPOE, and suggest ways in which it can be used for informating and strategizing to derive maximum value for quality assurance.

Medical Administration Process (MAP)

There are several different strategies used by hospitals to deliver medications to patients. Floor-Stock distribution is becoming commonplace in average and large sized hospitals. Floor-Stock distribution utilizes some type of medication dispensing equipment that is located in the patient areas rather than in the pharmacy. Some larger hospitals use a Decentralized Pharmacy system with satellite pharmacies operating in different areas of the hospital. Another common strategy is called Unit Dose, where drugs are packaged into unit of use doses and pharmacists review orders before drugs are dispensed to patients (McCarthy and Schafermeyer 2001). Some more advanced systems use automated robots to deliver orders throughout the hospitals, and pneumatic tube delivery has become very popular in newly constructed hospitals. The use of exchangeable carts for each area in the hospital is very common, and some hospitals simply use personnel to deliver orders as they are prepared. The systems used depend on management preference, hospital size, and hospital budget.

In general, the traditional medication ordering-dispensing administration process involves the following steps (Wong et al., 2003):

1. A physician hand-writes a prescription order sheet;
2. The physician places the prescription in a patient's chart and raises the chart's flag to indicate that there is a new order;
3. A nurse periodically looks for charts with new orders;
4. The nurse reviews the order and updates the patient's medication administration record (MAR) and places the carbon copy of the order in an outbox so it is delivered to the pharmacy;
5. A pharmacy technician picks up the new order forms periodically and drops them off at the pharmacy;
6. A pharmacist reviews the order, calls for clarification if needed, and enters the order into a computerized pharmacy information system. In some cases, the pharmacist codes the order in for a data entry technician to enter the order into the system;
7. Those orders that require clarification are put aside and processed only after they are cleared;

8. Labels are then automatically printed from the entered orders;
9. Pharmacy technicians attach the labels to medication bags, which are then filled with the medications indicated on the label.

Due to several potential areas for miscommunication and errors in MAP, an IS called CPOE has been introduced to support it. The MAP process through a typical CPOE includes the steps below:

1. A physician enters a medication order directly into the medication information system;
2. A pharmacist reviews the order on-line, calls for clarification if necessary, then releases or changes the orders on-line;
3. Labels are automatically printed;
4. Pharmacy technicians attach the labels to medication bags, which are then filled with the medications indicated on the label;
5. The pharmacy technicians deliver all dispensed medications to the wards at specified times throughout the day;
6. A nurse administers the medications to the patient according to the computer display.

Using value-added by IS as our theoretical framework, in the next three sub-sections, we discuss the role of CPOEs in Automating, Informating, and Strategizing.

Role of CPOEs in Automating

A comparison of the traditional and CPOE-based processes explained above shows that, in the current form, application of CPOE is mainly to speed up the process order medication and reduce errors. As seen, the process is shorter because of several improvements: the pharmacist has almost immediate access to the order; the times consumed to enter the same data multiple times is shortened; and the time to physically transfer a copy of the medication order from the hospital (or Physician's office) to the pharmacy is eliminated. The accuracy of the process is also increased as a result of different improvements: data entry points are reduced; and physician's handwriting is eliminated.

Speed, accuracy, error reduction, and reduction of paper-based processes are characteristics of the automating function of IS. A review of studies of CPOE-based medication ordering process, confirms the emphasis on the "automating" features of the system. The main goal in these studies is to improve the automation of medication ordering process. Some studies for example, run simulations and compare the traditional to CPOE-based process and propose how to operationally improve the medication ordering process (Yang et al. 2003; Wong et al., 2003). Other studies have demonstrated the effectiveness of CPOEs as automating systems- According to a study led by David Bates MD (Baker, 2002), Chief of General Medicine at Boston's Brigham and Women's Hospital (i) CPOE reduced error rates by 55% (ii) in a follow-up study it was found that the rates of serious medication errors fell by 88%. The prevention of errors was attributed to the CPOE system's structured orders and medication checks. (iii) An added benefit in case of a traveling patient loses prescription away from home or in need of refill CPOE can prove quite valuable.

Based on the evidence above, the CPOE has been used more as an automating information system, but we believe that these systems have the potential to informate and strategize as well.

Role of CPOEs in Informating

Some studies have shown that when paired with a Clinical Decision Support System (CDSS), CPOE's could be used for more than automating purposes (Kuperman, etal., 2007). For example, a CDSS can provide drug safety features such as checking for drug-drug or drug-laboratory interactions. Output from CPOEs when collected and analyzed can also serve to informate various stakeholders in MAP. For example, physician's can obtain reports on the use of specific medications by various patients; pharmacists can obtain reports based on certain patients, drugs, or physicians; and patients can use the system to set reminders for filling their prescriptions or taking their medications. Such services could be extended to web or mobile-based platforms of delivery.

Role of CPOEs in Strategizing

The data collected and gathered over time of the MAP can be used as input to business Intelligence (BI) tools for providing further insights in the process. For example, predictive analytics (Eckerson, 2007) could be conducted to find patterns for interactions of various medications, effectiveness of distribution channels, or to compare effectiveness of various medications for the same disease. Eventually such a system could be used as a knowledge base for physicians and pharmacists. Best practices in the ordering of drugs, filling of prescription, patient behavioral patters etc. can be identified to incorporate lessons learned. Customized services can be provided at the patient level for more innovative approaches to caregiving. Analyses at this level can help create competitive advantage for institutions and networks within the healthcare services. It can also be used to identify complementary competencies for potential strategic alliances and partnerships.

DISCUSSION

Quality assurance can be defined in different ways and this is the case in healthcare quality management. We believe quality assurance should be a holistic approach where quality is addressed at different levels. In line with this approach, we have proposed the application of a three-level theoretical framework in which the value-added contribution of information systems is differentiated at three levels of *automating*, *informating*, and *strategizing*. CPOE as one of the newest forms of information systems used in the healthcare industry promises to alleviate the quality of care by computerizing the process of medication ordering. In the current form CPOE's are used primarily at the automating level. We argue that in order to reap the full potential benefits that CPOE and other similar systems have to offer, they need to be used as *informating* and ultimately *strategizing* systems.

In addition, we argue that a holistic approach to quality assurance involves obtaining the three levels of value-added steps discussed above in this consecutive order: *automating*, *informating*, and *strategizing*. In other words, implementation of a CPOE should first aim at achieving automating features of the system. Once this goal is successfully achieved, the implementation

can move to the next level, informating. Strategizing should be accomplished at the last stage. Each stage encompasses the previous stage(s), therefore, it cannot precede that stage. For example, a strategic use of CPOE data to conduct business analytics cannot be achieved without the systems already having been automated and relevant data having been collected. As another example, physicians cannot obtain meaningful reports before having access to an automated integrated system. Given that CPOEs have been found to be successful at the automating stage, we believe that it is time for the healthcare industry to apply such systems to the next levels of value. This may address the recent calls for concern that quality improvement initiatives are not benefiting the bottom-line (Rauh et al., 2011). By contributing at the informating and strategizing levels, higher value can be derived from the system, which may lead to benefits such as improved bottom line being realized.

Finally, there need to be measures in place to assure value-added steps have been achieved. Various key performance measures (KPIs) can be defined at each level to assure the effectiveness promised by that level has been achieved. At the automating level, measures such as speed and accuracy can be used. Measures that help improve the processes operationally can be used as KPIs at the informating stage. Results of effective reporting and summarizing, such as effects on financial indicators of performance (e.g. ROI) can be considered as KPIs at the informating stage. Effectiveness at the strategizing stage can be measured by KPIs that adopt something akin to a balanced scorecard approach, where a multi-faceted view of performance is considered. By continuously running reports to monitor performance, strengths and weaknesses of the process can be identified and improvements can be made. Strategic initiatives that are as a result of using CPOEs can be considered relevant measures of the effectiveness of CPOEs as strategizing information systems.

Our goal in this paper was to introduce Framework of Value-Added by IS as a relevant theoretical framework to study quality assurance in healthcare. This paper is a stepping stone for future research that adopts such a framework to empirically investigate effectiveness of IS in increasing the quality of care.

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