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SEIPS-based process modeling in primary care

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ABSTRACT

Process mapping, often used as part of the human factors and systems engineering approach to improve care delivery and outcomes, should be expanded to represent the complex, interconnected sociotechnical aspects of health care. Here, we propose a new sociotechnical process modeling method to describe and evaluate processes, using the SEIPS model as the conceptual framework. The method produces a process map and supplementary table, which identify work system barriers and facilitators. In this paper, we present a case study applying this method to three primary care processes. We used purposeful sampling to select staff (care managers, providers, nurses, administrators and patient access representatives) from two clinics to observe and interview. We show the proposed method can be used to understand and analyze healthcare processes systematically and identify specific areas of improvement. Future work is needed to assess usability and usefulness of the SEIPS-based process modeling method and further refine it.

1. Introduction

The last decades in health care have been transformative, focused on improving quality of care and patient safety initiated by the US Institute of Medicine report "To Err is Human: Building a Better Health System" (Kohn et al., 1999). Healthcare delivery is in need of redesign to meet the needs of patients while providing safe, effective and efficient care (Institute of Medicine, 2001). Despite considerable efforts and substantial resources to improve patient safety, the results of the investment to date are equivocal and the need for successful and sustained redesigns remains (Agency for Healthcare Research and Quality, 2015). Health care remains focused on individual tasks, as do many improvement initiatives; only when the focus is shifted to support and add value to processes will quality of care truly improve (Walker and Carayon, 2009).

A systems engineering approach has been proposed to improve healthcare quality and patient safety (Kaplan et al., 2013; President's Council of Advisors on Science and Technology, 2014; Reid et al., 2005). Human factors engineering, in particular, has gained increasing recognition and can provide system design methods to address the needs and desires of stakeholders in the healthcare system and other important sociotechnical aspects of health care (Gurses et al., 2011; Reid et al., 2005). As Walker and Carayon (2009, p. 471) note, "Human-factors engineering (HFE, the application of knowledge regarding human characteristics to the design of work systems) can provide theoretical and pragmatic guidance to process design." It is important to shift from task-level to process-level analysis (Carayon et al., 2015a; Hettinger et al., 2015).

HFE methods can be utilized to design safer and more efficient processes, resulting in improved patient care quality and provider satisfaction (Walker and Carayon, 2009; Xie and Carayon, 2015). HFE-based process-level analyses are particularly valuable and applicable in primary care where patients experience a wide range of complex, inter-connected care processes. Process modeling methods can be used to document and establish a shared understanding of existing processes; this can be leveraged to identify improvement areas (Jun et al., 2009; Siemieniuch and Sinclair, 2005). The terminology associated with this work has varied, and "workflow" is increasingly used interchangeably with "process"; the term used in the original articles is used in this literature review. In the remainder of the paper, we suggest and use "process."

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2. HFE-based process modeling in health care

Early process design research was conducted in structured manufacturing environments (Siemieniuch and Sinclair, 2005). Researchers have developed and refined approaches to study increasingly complex workflows, such as those in health care (Unertl et al., 2010). Workflow-modeling methods have been developed and used in other complex industries, but health care has not used these methods systematically (Jun et al., 2009; Unertl et al., 2010). Jun et al. (2009) evaluated eight modeling methods for three healthcare processes:

1. Patient discharge from a ward
2. Primary care diabetic patient care
3. Prostate cancer diagnostic procedure in a hospital.

Clinical and non-clinical staff evaluated the following workflow modeling methods based on familiarity with, usability and utility of the method:

- Stakeholder diagrams
- Information diagrams
- Process content diagrams
- Flowcharts
- Swim lane activity diagrams
- State transition diagrams
- Communication diagrams
- Data flow diagrams.

According to Jun et al. (2009), the first three methods show hierarchical links between stakeholders, information and activities; the next three preserve temporal links between activities; and the last two show inputs and outputs between stakeholders and activities. Flowcharts and swim lane activity diagrams were found to be the most commonly used, and flowcharts were found to be the most usable and useful of the methods evaluated. Ultimately, all methods were found to produce simplified representations of reality and none could effectively capture all aspects of the complex workflows found in health care (Jun et al., 2009).

Jun et al. (2010) extended this work and evaluated two additional methods: sequence diagrams and Integrated Definition for Function Modeling (IDFM). They also characterized each method based on the focus of the method (activity, stakeholder and information) and linkage type (hierarchical, sequential and information) in order to educate healthcare workers on methods available and their similarities and differences. Healthcare workers were most familiar with flowcharts. The researchers argue that greater use of modeling methods will lead to a better system understanding, especially considering the complexity and diversity of healthcare systems.

Examples of process mapping abound. Risk management projects especially use process mapping to identify vulnerabilities in processes, such as the healthcare failure mode and effects analysis (FMEA); an example of an FMEA can be found in van Tilburg et al. (2006). Flow diagrams showed the proportion of high-risk failures to total potential failure modes of each process step in ordering and administration of chemotherapy in a pediatric oncology unit. Medication ordering and administration processes in hospitals and outpatient care have been described using process mapping (Beuscart-Zéphir et al., 2007; Johnson and Fitzhenry, 2006). The ordering of diagnostic tests and physician interactions with technology have also been studied with process mapping in outpatient settings (Asan et al., 2015; Hallock et al., 2006). Unertl and colleagues used process mapping to compare work and information flow across multiple clinics (Unertl et al., 2009) and to look for patterns in health information exchange use across hospitals and clinics (Unertl et al., 2012). Eason et al. (2012) mapped care pathways to study the use of electronic patient information systems to span organizational boundaries. This analysis focused on the entire patient care process, therefore including various organizations and examining interdependencies related to crossing organizational boundaries (Eason et al., 2012). Some studies have modeled workflow of multiple clinicians providing care for individual patients, such as in emergency departments (Laxmisan et al., 2007; Ozkaynak and Brennan, 2013) and hospital admissions (Benyoucef et al., 2011; Puentes et al., 2012). Process mapping has also been used to study communication processes (Kummerow Broman et al., 2015) and interruptions (Brixey et al., 2008).

As these examples demonstrate, process modeling is increasingly used in health care. However, current process models may not systematically capture information on all work system elements (Carayon, 2009; Smith and Carayon-Sainfort, 1989) and may not adequately represent the complex, interconnected sociotechnical aspects of health care (Jun et al., 2009). These methods tend to be primarily used for descriptive purposes but not evaluation, i.e. to identify what is working or not working in the process; one exception is proactive risk analysis such as failure mode and effects analysis (Carayon et al., 2011b). HFE can help to gain a complete understanding of the process and associated work system (Carayon et al., 2004; Walker and Carayon, 2009). In this paper, we propose a new process modeling method to describe and evaluate processes by representing the sociotechnical aspects of the process. The Systems Engineering Initiative for Patient Safety (SEIPS) model (Carayon et al., 2006; Carayon et al., 2014b) is used as the conceptual framework for the proposed method. A systems approach is needed to ensure all work system elements are considered in the process analysis. We present a case study to demonstrate the application of the SEIPS-based process modeling method and discuss directions for future work.

3. The SEIPS model as a conceptual framework for process modeling

The SEIPS model integrates human factors and healthcare models to propose a systems engineering model to understand the care process by representing all work system elements; this model provides a representation of the complexities of health care (Carayon et al., 2006). The work system in the SEIPS model is composed of six elements and interactions between the elements (Carayon et al., 2006; Carayon et al., 2014b; Smith and Carayon-Sainfort, 1989) (see Fig. 1):

- People, including the patient, their family and/or caregivers and health care professionals involved in the process
- Tasks, which are goal-oriented activities within the process
- Tools and technologies, including health information technology and other tools used in the process
- Organization, including characteristics such as the culture, rules, procedures, management and leadership
- Physical environment, including layout, lighting, noise and distractions
- External environment, including payment, care delivery and legal and reporting systems.

A process is a “set of interrelated or interacting activities that use inputs to deliver an intended result” (ISO, 2015). In health care, outcomes include (1) patient outcomes, including quality of care and patient safety, and (2) employee and organizational outcomes such as job satisfaction and stress (Carayon et al., 2006; Carayon et al., 2014b; Schultz et al., 2005). The work system can be used