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Studying the impact of interoperable electronic health records on workflow in ambulatory care



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ABSTRACT

Many of the proposed benefits of health information systems, particularly those regarding efficiency, are assumed to be caused by changes in clinical provider and staff workflow. Assessing the extent to which electronic health records (EHRs) are having the expected effects and identifying barriers to anticipated improvements requires a detailed understanding of how such systems affect day-to-day work activities. This study utilized interviews and observations to develop prototypical workflow models of day-to-day activities in ambulatory practices, allowing activity changes due to the implementation of EHRs with varying levels of interoperability to be identified. Primary and specialty care practices from a multi-county region were sampled. Results showed that EHRs did not consistently improve efficiency, but variously reduced, added, or simply changed work tasks. The impact depended on the work process, level of interoperability, and type of provider involved, as well as aspects of the user interface design. Additionally, implementing EHR systems did not eliminate the use of paper from work processes. Implications for successful implementation and design of EHR systems are provided.

Relevance to industry: Effectively designing and implementing health IT systems in clinical settings requires an understanding of how the IT system will impact, and be integrated with, existing work activities, and how these impacts may depend on the level of interoperability achieved by the IT system.

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1. Introduction

1.1. Health IT implementation

Electronic health records (EHR) and other forms of health information technology (IT) are being rapidly implemented within a variety of health care environments. These developments are due in part to the American Recovery and Reinvestment Act of 2009, with \$19 billion to go towards provider incentives for the implementation of health IT (Blumenthal and Tavenner, 2010). Health IT

supports storage, retrieval, sharing, and use of health information (Chassin and Galvin, 1998; Thompson and Brailer, 2004), and is widely seen as providing benefits such as improved quality of care, reduction in medical errors, reductions in healthcare costs and expansion of healthcare access (Bernstam and Johnson, 2009; Blumenthal and Tavenner, 2010; Board of Health Care Services, 2012; Chaudhry et al., 2006; Stead and Lin, 2009). For example, EHR systems, which replace and augment traditional paper patient charts, may result in reduced medical staff cognitive demands, increased workflow efficiencies, increased information access and improvements to quality of care (Armijo et al., 2009; Kossman, 2006).

While the implementation of health IT is predicted to have wide ranging benefits, there are accompanying challenges which may

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impact successful deployment. New technologies are often designed with a limited or “rationalized” understanding of the work they need to support or are designed with a focus on administrative functions (e.g., record keeping; billing) rather than on contextualized, core work activities (i.e., patient care as it occurs in practice) (Button and Harper, 1993; Sachs, 1995). In safety critical systems such as health care it is vital that the impact of new information technology on work activities, safety, and patient care, be understood before implementation. Without such care in design, new systems may have negative effects or even be abandoned (Berg, 1997). Thus, it is critical to understand the context (i.e., workflow, information requirements, patient mix) of each particular healthcare organization where health IT will be deployed, in order to increase positive outcomes such as cost reductions and quality of care improvements (Chaudhry et al., 2006; Stead and Lin, 2009) while reducing the chance of drawbacks such as workflow interruptions, delays, and new forms of error (Kaufman et al., 2006; Kossman, 2006; Kushniruk et al., 2004; Patterson et al., 2004).

1.2. Impact of interoperability

Interoperability in health IT refers to the degree to which information is shared within and between organizations through IT systems (HIMSS, 2005). Electronic health record systems certified under the Health Information Technology for Economic and Clinical Health (HITECH) Act are required to contain certain functionalities supporting interoperability (such as the ability to exchange laboratory data) (Lenert and Sundwall, 2012). A lack of information exchange, bioimaging and other technical standards, and high upfront costs to integrate new health information technology systems limit the ability of currently implemented systems to reach their full potential in terms of data storage and retrieval and stunt the implementation of new products in favor of outdated or legacy systems. Such limits in interoperability are seen as a factor in rising health care costs, similar to limits seen and mitigated in the manufacturing industry (Sriram and Fenves, 2009); thus, improvements in interoperability are key to realizing one of the anticipated benefits of health IT – decreased costs. Providing effective, efficient, and high quality healthcare may be affected by how much information is shared within and between clinical settings, and how well that information is integrated within each clinical settings’ systems and processes (Guarrera et al., 2013). For instance, if laboratory reports are automatically linked to patients’ EHRs when they arrive, manual process steps (filing reports in charts) may be eliminated. However, this process improvement may not be realized if staff members have to open and associate incoming reports with individual patients. Likewise, the speed and ease of access to data from the reports (important for clinician review) can vary considerably if values or information are directly imported into fields or sections of a patient chart, rather than attached as images or files to the record which require a number of steps to access and page through.

1.3. Workflow modeling

Successful IT systems must provide high availability with low system management overhead, high data integrity and a high degree of usability in terms of effectiveness, efficiency and satisfaction (Dix et al., 1998; Sharp et al., 2007; Stead and Lin, 2009). Designing systems which are usable and useful requires an understanding of the users of the system, the context and environment of the system, necessary tools and information, daily work practices and work activities that could require and potentially benefit from, use of the system (Bennett, 1984). This understanding can be achieved by

using methods such as process flow modeling (Groover, 2007) to assess clinical workflows.

There have been several studies that have taken a workflow modeling approach to understand the impact of health information systems. However, despite the need to understand the impact of health IT across a wide range of healthcare settings including primary and specialty ambulatory care, most examples are of specific hospital processes, including Intensive Care Units (ICUs) (Cheng et al., 2003; Reddy et al., 2005; Shaw et al., 2009) and emergency and non-emergency care (Carstens et al., 2009). For example, Cheng et al. (2003) observed the workflow at one ICU after implementation of a mandatory Computerized Physician Order Entry (CPOE) system to gather conceptual themes and workflow characteristics. Their results indicated that introducing health IT will change work practices, and that designing systems that are incompatible with work processes can result in unexpected changes in workflow, potentially creating issues like the need for work-arounds and redundancies that increase work and interruptions. Horsky et al. (2006) used observation and interview methods to understand the work practices of triage nurses, using subsequent workflow modeling to identify areas where clinicians need support tools or technological intervention. They found that the cause of many delays, inefficiencies and opportunities for error were a result of failures in the interaction between human and system, due to poor integration of health IT into the workflow. Unertl et al. (2009) do provide an example of a study within ambulatory care practices that have implemented EHRs, but their study was limited to clinics specific to chronic disease care. They analyzed information gathered through direct observation and semi-structured interviews, modeling workflows and information flows. These models were used to identify gaps between the existing health information system functionalities and the needs of the providers. For example, the EHR in use was originally designed for primary care, but was in use for chronic disease management. An evident outcome of the study was the need for module or template specific functionality catered to specific specialty care domains. Johnson and Fitzhenry (2006) also studied workflow in an ambulatory care setting. However, they studied and modeled only outpatient prescribing to understand requirements prior to the implementation of an electronic prescribing system. Generally, they found that prescribing activities varied by practice size, setting and specialty type. Despite the evident pursuit of the effects of health IT on work practices in these current studies, none of them take this analysis a step further, assessing workflow changes with respect to interoperability, a key component to successful health IT implementation.

In summary, effectively designing and implementing health IT systems in clinical settings requires an understanding of how the IT system will impact, and be integrated with, existing work activities, and how these impacts may depend on the level of interoperability achieved by the IT system. Current research to date has identified some impacts of health IT on workflow in hospital settings, or in specific components of ambulatory care. However, these studies have not addressed impacts on ambulatory care workflows more broadly, nor have they specifically examined the effects of systems with different, and sometimes multiple, levels of interoperability. Thus, the objective of the present study was to document a broad range of interoperability-level specific workflows in ambulatory practices which have either implemented, or plan to implement, interoperable EHRs, in order to assess the impacts of health IT on work. This study used interview and observational methods to collect data at thirteen primary and specialty ambulatory care offices. A wide range of workflow types were studied and modeled. Data was used to develop practice-specific and prototypical workflows, and participant comments regarding the technology were also analyzed using qualitative methods. The results demonstrate

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