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We work with them? Healthcare workers interpretation of organizational relations mined from electronic health records

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ABSTRACT

Objective: Models of healthcare organizations (HCOs) are often defined up front by a select few administrative officials and managers. However, given the size and complexity of modern healthcare systems, this practice does not scale easily. The goal of this work is to investigate the extent to which organizational relationships can be automatically learned from utilization patterns of electronic health record (EHR) systems.

Method: We designed an online survey to solicit the perspectives of employees of a large academic medical center. We surveyed employees from two administrative areas: (1) Coding & Charge Entry and (2) Medical Information Services and two clinical areas: (3) Anesthesiology and (4) Psychiatry. To test our hypotheses we selected two administrative units that have work-related responsibilities with electronic records; however, for the clinical areas we selected two disciplines with very different patient responsibilities and whose accesses and people who accessed were similar. We provided each group of employees with questions regarding the chance of interaction between areas in the medical center in the form of association rules (e.g., Given someone from Coding & Charge Entry accessed a patient's record, what is the chance that someone from Medical Information Services access the same record?). We compared the respondent predictions with the rules learned from actual EHR utilization using linear-mixed effects regression models.

Results: The findings from our survey confirm that medical center employees can distinguish between association rules of high and non-high likelihood when their own area is involved. Moreover, they can make such distinctions between for any HCO area in this survey. It was further observed that, with respect to highly likely interactions, respondents from certain areas were significantly better than other respondents at making such distinctions and certain areas' associations were more distinguishable than others.

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Conclusions: These results illustrate that EHR utilization patterns may be consistent with the expectations of HCO employees. Our findings show that certain areas in the HCO are easier than others for employees to assess, which suggests that automated learning strategies may yield more accurate models of healthcare organizations than those based on the perspectives of a select few individuals.

1. Introduction

The healthcare community has made considerable strides in the development of information technology to support clinical operations in healthcare organizations (HCOs). These advances stem from a variety of factors, including commercialization of health information technology (HIT) and policy making that promotes the uptake of such technologies (e.g., the "meaningful use" incentives offered in the United States [1–3]). While there is evidence that health information technology (HIT) can improve the safety [4–6] and the efficiency [7,8] of healthcare delivery, there remain considerable obstacles to adoption and realization of these benefits on a massive scale [9,10].

In particular, as HIT, and the healthcare workforce more generally, grows in diversity, so too do its complexity [11–13]. This is a concern because, despite the aforementioned benefits, there is also evidence to suggest that HIT can contribute to (though is not necessarily the cause of) the interruption of care services [14,15], induce medical errors [16,17], and expose patient data to privacy breaches [18,19]. Moreover, such events tend to be discovered only after they have transpired *en masse*, leading to undesirable popular media coverage [20,21], loss of patients' trust [22–24], and sanctions imposed by state and federal agencies [25,26].

It has been suggested that such problems can be mitigated through the integration of rules to recommend against or even prohibit certain actions (e.g., the prescription of two drugs in combination that are known to cause an adverse reaction [27,28]). At the same time, it is recognized that no rules-based system is perfect and that exceptions need to be granted. These exceptions can, in turn, be audited to determine if the existing set of rules are in alignment with the expectations of the HCO or if they need to be revised to more accurately represent healthcare operations [29,30]. For instance, it has been shown that the exposure of patient records (and thus the violation of their privacy) can be lessened through access control [31–36], which allocates permission to patient information on a need-to-know basis. In this setting, exceptions are granted through a "break the glass" failsafe that allows HCO employees to escalate privileges if necessary [37]. For instance, in a study in the Central Norway Health Region, over the course of a one-month period, it was observed that 54% of 99,000 patient's records had their glass broken by 43% of 12,000 healthcare employees [38]. Patterns of escalation can subsequently be applied by HIT system administrators to evolve access control configurations [39–42].

Data-driven approaches to HIT improvement will only be acceptable to HCO administrators if the patterns of HIT utilization reflect the expected operations of healthcare environments. This paper begins to address this issue by investigating how a specific type of HIT utilization pattern, which has been suggested for use in audit and refinement of access control models [43–46], aligns with the expectations of employees in a large academic medical center. To do so, we designed a survey to capture the degree to which employees agree with relational patterns (i.e., the likelihood that certain HCO areas in a medical center coordinate to support a patient) as inferred by actual utilization of an electronic health record (EHR) system [47]. This survey was conducted with employees from four areas in the Vanderbilt University Medical Center (VUMC). It was designed to determine if employees (1) agreed with the distinction between relationships of high and non-high likelihood and (2) were better at assessing relationships regarding their own area as opposed to others in the institution.

Our findings illustrate that employees can, with statistical significance, clearly distinguish between relationships of high and non-high likelihood. Moreover, we find that employees were capable of performing such assessments for all of the HCO areas in the study, which implies that our results are robust against bias induced by self-perception. To the best of our knowledge, this is the first study to illustrate humans agree with the organizational models that can be mined from EHR access logs.

2. Background

2.1. Learning organizational models

Organizations are often structured to support the completion of certain tasks. As a result, when a task is complex (e.g., a patient who is associated with multiple ailments, which need to be treated by different sections of a hospital), traditional organizational management strategies are often inadequate [48–50,73]. Managers in such environments tend to exhibit low productivity as a consequence of attempting to coordinate complicated relations [51]. It has been shown that the integration of information technology into an organization's business practices, can facilitate the flattening of rigid hierarchical organizations and, thus, enable greater agility [52,53,74,75]. Thus, over the past several decades, there has been a significant amount of research dedicated to inference and modeling of organizational structures, particularly with respect to information technology [54–56].

At the same time, it has been recognized that the relationships within a collaborative environment are often dynamic and context-dependent. Based on this observation, data-driven learning models have been proposed to represent dynamic relations and uncertain context in organizations