Use patterns of health information exchange systems and admission decisions: Reductionistic and configurational approaches

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ARTICLE INFO

ABSTRACT

Background: Research that endeavors to identify the value of electronic health information exchange (HIE) systems to the healthcare industry and, specifically, to clinical decision making is often inconclusive or theory-based. Studies seeking to identify how clinical decisions relate to patterns of actual HIE use, often by analyzing system log files, generally rely on dichotomous distinctions between system use and no-use, disregard the availability of information in the system, and control for few user characteristics.
Objective: We aim at empirically exploring the associations between use patterns of HIE systems and subsequent clinical decisions on the basis of broad definitions of use patterns, available information, and control variables.
Methods: We examine the decision to admit critically-ill patients either to the intensive care unit (ICU) or to another ward at a busy emergency department in the period 2010–2012. Using HIE log files, use patterns are characterized by the variables of number of users, volume, diversity, granularity, duration, and content. We test the association between HIE use patterns and the admission decision, after controlling for multiple demographic, clinical, physician, and situational variables and for available HIE information. This association is examined by taking a reductionistic approach that focuses on independent use variables and a configurational approach that focuses on use profiles.
Results: Five use profiles were identified, the largest of which (46.95% of encounters) described basic HIE access. ICU admission is more probable when the HIE system is perused by multiple users (odds increase by 31%) and when use profiles include prolonged screen viewing (odds increase by 159%) or access to diverse and multiple types of information, specifically on test results, procedures, and previous encounters.
Discussion: Reductionistic and configurational approaches yield complementary insights, which advance the understanding of how actual HIE use is associated with clinical decision making. The study shows that congruent profiles of HIE use enhance the predictability of the admission decision beyond what can be explained by independent variables of HIE use.

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1. Introduction

Electronic health information exchange (HIE) systems integrate and display patient-level data that originate from multiple electronic sources [1]. Whereas electronic health record (EHR) systems focus on managing health information, order entry, and decision support, HIE systems aim to bridge information gaps that result from the multiplicity of patient needs and healthcare providers [2]. These information gaps jeopardize patient safety and are a cause of redundant clinical procedures, which are estimated at millions of dollars annually [3]. The investment in HIE, however, often surpasses the return on investment, especially because it is difficult to measure this return, particularly in a short time span [4]. Whereas HIE systems have been subjected to scrutiny in various studies that have attempted to identify their value to the healthcare industry and, specifically, to clinical decision making, the findings of such studies have often been inconclusive or theory-based [5].

Key components of assessing and realizing the potential benefits of such information systems are effective integration into the users' workflow [6,7] and actual use [7–9], particularly at the individual level [1]. In recent years, several attempts have been made to identify patterns of actual HIE use [1,10–13], often by analyzing log files, which document user activities and information accessed within the system.

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To move beyond the dichotomous distinction between system use and no-use, which is often considered insufficient [14], research adopts both reductionistic and holistic approaches to quantitatively characterize HIE use patterns. The *reductionistic approach* models phenomena parsimoniously through simple, often linear, relationships between separate and independent variables [15]. Studies adopting this approach characterize HIE use through basic descriptive methods, such as frequencies, sequences, and types of screens viewed by system users [12,16–18]. Contrariwise, the notion of *holism*, upon which the *configurational approach* is based, describes behaviors as profiles (i.e., configurations) of mutually supportive factors, which do not necessarily vary independently or linearly [15,19]. Studies adopting this approach describe HIE use as archetypes of user behavior [11,20]. While both approaches are deemed valuable in explaining and predicting behavior and performance, the configurational approach is implemented mostly at the organizational level [21,22].

Few studies empirically examine the link between individual use patterns and healthcare performance, as reflected by clinical decisions. While these studies associate HIE use with lower odds of admission [23,24], they succinctly describe use patterns and disregard the actual availability of information in the system. When included in studies, the availability of information via the system is generally linked to fewer ancillary tests, shorter length of stay (LOS), and decreased hospitalization rate [25,26], while ignoring whether the information was actually accessed. Moreover, user characteristics are absent in many studies, despite their effect on system use, judgment, and cognitive style [27,28].

The objective of this study is therefore to conduct an integrative and comprehensive exploration of HIE use patterns and their association with clinical decision making, through a fine-grained analysis that incorporates the various perspectives on system use. We characterize use patterns through both reductionistic and configurational approaches and then compare their predictive value. The marginal value of use patterns (i.e., the change in the outcome variable for a given use pattern with other conditions remaining the same) is isolated by controlling for the information available in the system and for an extended set of patient-, physician-, and encounter-related variables. This objective is pursued in the context of critically-ill patients who were treated at the resuscitation room (RR) in the emergency department (ED) and then considered for admission to the intensive care unit (ICU) versus an alternative ward.

EDs represent an environment abundant with information gaps, commonly in medical history and laboratory test results [29], leading to the conjecture that efficient HIE may contribute most to EDs [30,31]. While the care of critically-ill patients who arrive to the ED is likely to significantly benefit from accessible information via HIE, its inquiry may consume valuable time and effort. Despite positive perspectives of HIE [32], ED physicians usually do not exploit the system and its abilities [11].

The ICU is the destination for many critically-ill patients after being treated in the ED. ICUs often represent over 10% of hospital costs and are therefore considered highly demanding yet limited in terms of resources [33]. While admitting a patient to the ICU requires reasoning and justification, selection criteria for admission to the ICU versus a regular ward remain equivocal [34]. This reality motivates a meticulous examination of patterns of actual system use and their association with clinical decisions, particularly in the context of ICU admission decisions in ED settings.

2. Methods

This study is conducted in a large Israeli hospital, in which the OFEK HIE system (dbMotion, Israel) has been implemented. HIE
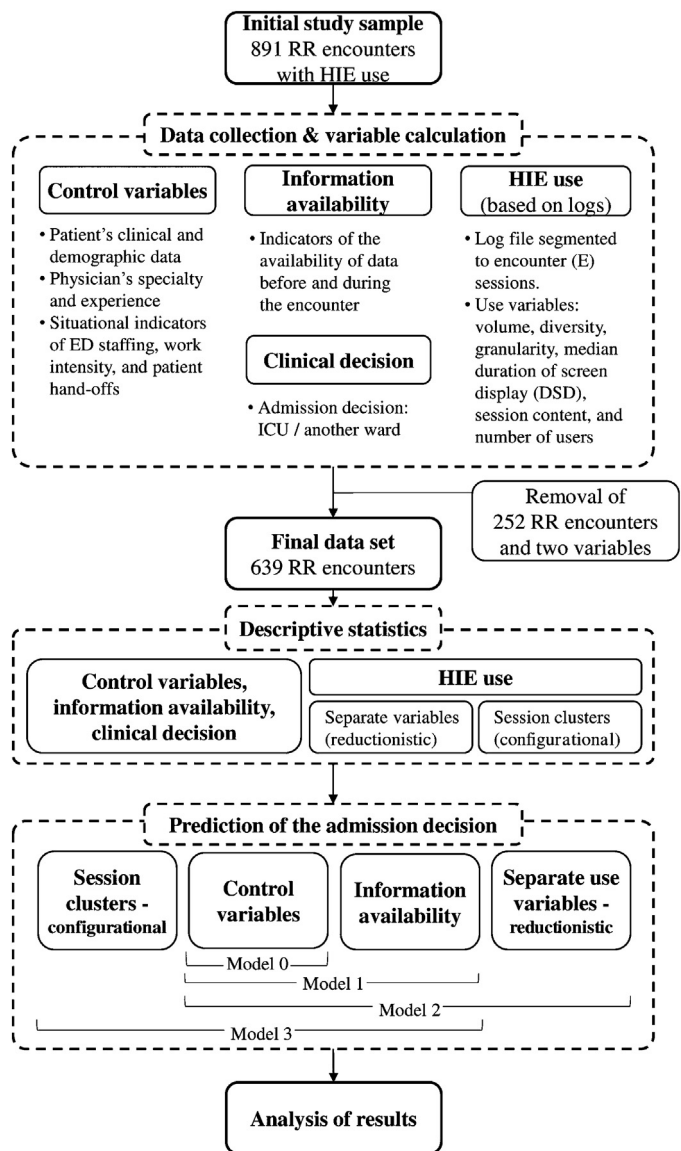

Fig. 1. The current study's workflow.

use patterns are extracted from log files that document all physician activity during 891 treatments given in a three-year period (2010–2012) to critically-ill patients in the RR. The value of HIE use patterns to clinical decisions is assessed in the context of the ICU admission decision for these patients. Fig. 1 graphically summarizes the workflow of this study, focusing on aspects of data collection, processing, and analysis.

2.1. Setting

The setting for the current retrospective, observational study is the internal ED of Soroka University Medical Center (SUMC), the fourth largest hospital in Israel that serves over one million people. SUMC is operated by Clalit Health Services, the largest healthcare provider in Israel, which treats over 50% of the country's population. SUMC's internal ED treats over 100,000 patients annually, some of whom are considered critically-ill and are hence treated at the resuscitation room (RR), operated only upon demand. Due to patients' often non-communicative state, medical data are obtained in the RR via secondary sources such as an HIE system, the patient's medical record, and family members. Patient charts docu-