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Realizing Quality & Experience Benefits Through EHR Adoption & Use: A Conceptual Model

Gurprit K. RANDHAWA[a,1]
[a] *Manager, Clinical Improvements & Informatics, Island Health, Victoria, BC*

Abstract. A conceptual model of EHR adoption and use is presented, which details the components necessary to realize both quality and experience benefits. The model was developed based on a review of the conceptual and theoretical frameworks related to technology adoption/use and quality in health care. It includes 42 constructs, six key constructs, three antecedents, four moderator variables, and two key benefit areas (i.e., quality and experience) at the micro, meso, and macro levels. The model has been operationalized through identification of over 130 metrics for measuring the constructs. The model may be used to inform planning, decision-making, and evaluation of EHR implementations and benefits realization. It is recommended that the EAU model be further tested.

Keywords. Electronic Health Records, Benefits Realization, Conceptual Model.

1. Introduction

The adoption and use of electronic health records (EHR) has been proposed to improve quality in health care [1,2]. However, there is currently limited evidence on the positive effects of EHRs on quality [3]. Further, although "quality" is widely referred to as an organizational goal in health care, it is unclear what "improve quality" actually means, especially related to use of the EHR [4]. For health care organizations such as Island Health that have adopted an EHR to facilitate the realization of purported quality benefits, the lack of a standardized definition for quality and corresponding dimensions and metrics to evaluate quality is a significant barrier to achieving and measuring quality benefits. Additionally, with the release of the Institute for Healthcare Improvement's new Quadruple Aim Framework [5], the "experience" of patients and providers is an emerging area and outcome of interest for health care organizations. Patient experience is defined as "the sum of all interactions, shaped by an organization's culture, that influence patient perceptions across the continuum of care" [6]. Similarly, *clinician experience* refers to the "work life of health care providers, clinicians and staff" [7]. Given burgeoning research on provider burnout resulting from EHRs [9], the role of EHRs in improving patient and provider experience needs to be further explored.

In order for organizations to fully realize EHR benefits in quality and experience, there is a need to identify: (1) the dimensions of quality and experience, (2) metrics to measure quality and experience, and (3) the prerequisite components of EHR adoption.

[1] Corresponding Author.

This paper proposes an evidence-based conceptual model of EHR adoption and use (EAU) to support health care organizations in understanding the "big picture" of EHR adoption, use, and quality/experience benefits realization. By identifying metrics for measuring the constructs, the EAU model has also been operationalized for measurement to support formative evaluation of EHR adoption/use and benefits realization at Island Health and other health care organizations.

2. Background

To explore the relationship between EAU and quality benefits realization, the EAU model (Figure 1) was developed at Island Health from June 2017 to January 2018 following a review of frameworks and literature related to technology adoption/use and health care quality. In general, quality and EHR adoption frameworks developed in Canada were selected. The EAU model was developed as a conceptual model, as conceptual models depict conceptual frameworks, organize constructs and relationships [20], and are very helpful in complex or rapidly emerging fields [20].

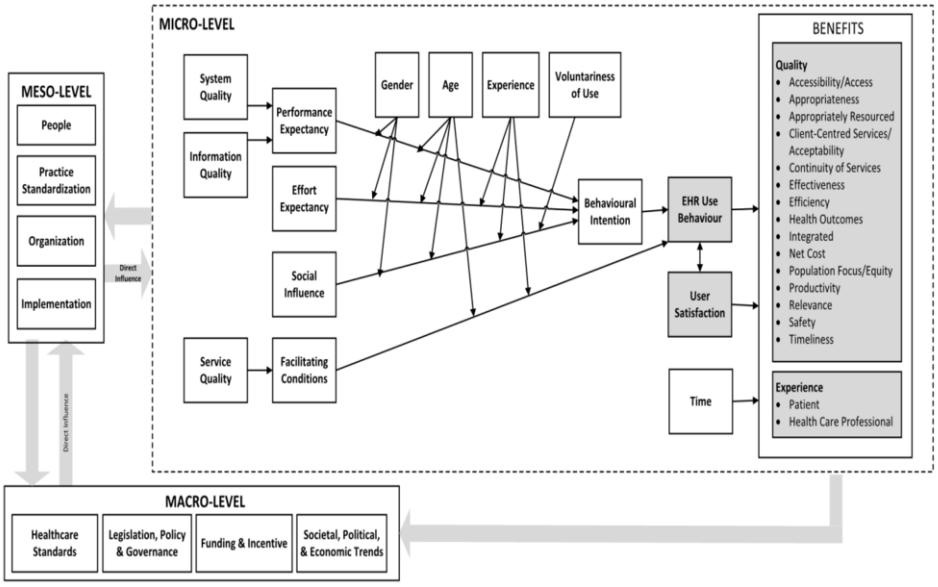

Figure 1. EHR Adoption & Use (EAU) Model

The EAU Model is based on ten technology adoption/use and quality frameworks used at the local, provincial, national, and international levels: (1) the Unified Theory of Acceptance and Use of Technology (UTAUT) [10]; (2) Canada Health Infoway's Benefits Evaluation (BE) Framework [11]; (3) the eHealth Observatory's Clinical Adoption Framework (CAF) [12]; (4) Island Health's Quality Framework [13]; (5) the BC Health Quality Matrix [14]; (6) The Clinical Systems Transformation (CST) Benefits Framework [15]; (7) the Agency for Healthcare Research and Quality (AHRQ) Domains of Health Care Quality [16]; (8) Health Quality Ontario's Quality Attributes [17]; (9) Accreditation Canada's Dimensions of Quality Care [18], and (10) the Clinical Adoption

Meta-Model [19]. As such, the EAU model combines 42 evidence-based constructs/components of technology adoption/use with universal quality benefits that can be measured for EHR benefits realization at three levels: micro (individual level), meso (organizational level), and macro (national/international level). In total, the model includes six key constructs, three antecedents, four moderator variables, and two key benefit areas (i.e., quality and experience). Given that the EAU model is a diagram/picture of the relationships between constructs, it is referred to as a model instead of a framework. Feedback to improve and validate the model was sought from a subject matter research expert from the University of Victoria's School of Health Information Science. The model was then presented to Island Health leaders who were key stakeholders for supporting EHR Adoption, use, and benefits realization at Island Health, including the Chief Medical Information Officer, the Executive Medical Director of Quality & Safety, the Director of Clinical Improvements & Informatics, the Director of Provider Learning & Knowledge Translation, and the Director of Clinical Learning & Knowledge Translation. Following iterative refinement (e.g., addition of "experience" construct) and organizational approval of the model, the EAU model was operationalized (described in the next section). In November 2017, based on feedback from Island Health's Director of Professional Practice, the EAU model was further revised to include a new meso-level construct that was not included in the reviewed literature: practice standardization. Since its development, the EAU model has been applied to conduct formative EHR evaluation studies at Island Health.

2.1. Key Benefit Areas: Quality and Experience

Quality and experience are the end-goals or key benefit areas of the EAU model. **Quality** includes the sub-constructs of accessibility/access [11,12], appropriateness [14] appropriate resourcing [17], client-centered services/acceptability [16], continuity of services [13], effectiveness [14], efficiency [13], health outcomes [11,12], integration [17], net cost [11,12], population focus/equity [14], productivity [11,12], relevance [18], safety [16], and timeliness [16]. **Experience** includes patient experience and provider experience, as earlier defined. The sub-constructs of quality are outlined in the table below, including corresponding definitions and source references.

Table 1. Sub-Constructs of Quality in Health Care

Sub-Construct	Definition	Reference
Accessibility/ Access	"Ability of patients and providers to access timely and equitable services."	BE/CAF [11,12]
Appropriateness	"Care provided is evidence-based and specific to individual clinical needs."	BC Health Quality [14]
Appropriately Resourced	"The health system should have enough qualified providers, funding, information, equipment, supplies and facilities to look after people's health needs."	Health Quality Ontario [17]
Client-Centered Services/ Acceptability	"Providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions."	Institute of Medicine [16]
Continuity of Services	"Patient care is coordinated across the continuum."	Island Health [13]
Effectiveness	"Care that leads to the best possible results."	BC Health Quality [14]
Efficiency	"Optimal use of resources to yield maximum benefits and results."	Island Health [13]

Health Outcomes	"Clinical outcomes and change in health status attributable to the eHealth intervention."	BE/CAF [11,12]
Integrated	"All parts of the health system should be organized, connected and work with one another to provide high-quality care."	Health Quality Ontario [17]
Net Cost	"Monetary avoidance, monetary reductions, savings."	BE/CAF [11,12]
Population Focus / Equity	"Distribution of health care and its benefits fairly according to population need."	BC Health Quality [14]
Productivity	"Efficiency, care coordination and net cost."	BE/CAF [11,12]
Relevance	"The services being provided must be relevant to the group of people being served."	Accreditation Canada [18]
Safety	"Avoiding harm to patients from the care that is intended to help them."	Institute of Medicine[16]
Timeliness	"Reducing waits and sometimes harmful delays for both those who receive and those who give care."	Institute of Medicine [16]

2.2. Micro-Level Components

Realizing the benefits of quality and experience is dependent on three constructs: EHR use behavior, user satisfaction, and time. **EHR use behavior** is "the frequency, duration, location, type or nature and flexibility of actual usage that took place" [11,12]. **User satisfaction** refers to "the subjective opinions of users in terms of their perceived expectations, information/system/services quality and use of the system" [11,12]. It is important to note that quality and experience benefits may be realized at different **time** points post-implementation of the EHR [19]. The time dimension is often missed in conceptual models for EHR adoption, use, and benefits realization.

The EHR use behaviour construct is influenced by five constructs: behavioral intention, performance expectancy, effort expectancy, social influence, and facilitating conditions. While **performance expectancy** is "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" [10], **effort expectancy** is "the degree of ease associated with the use of the system" [10]. **Social influence** is "the degree to which an individual perceives that important others believe he or she should use the new system" [10]. **Facilitating conditions** refers to "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" [10]. Micro-level antecedents include **system quality** (i.e., technical aspects of HIT), **information quality** (i.e., characteristics of the data in the system), and **service quality** (e.g., for training and ongoing support) [11,12]. **Moderator variables** include gender, age, experience (i.e., work experience), and voluntariness of use [10].

2.3. Meso-Level Components

At the meso-level, there are four constructs that directly influence the micro-level: people, practice standardization, organization, and implementation. **People** refers to "all individuals or groups that are involved with the system" [12], whereas **organization** is "the strategy, culture structure, business process, information infrastructure, return on value and their relation to the system" [12]. **Implementation** is "the project plan regarding adoption, management and the fit of the system with the future and present operations" [12]. **Practice standardization** refers to the use of standard clinical practices in the organization. This construct was not identified in the frameworks reviewed from

the literature; instead, it was included as a lesson learned from Island Health's 2016 implementation of the EHR in Nanaimo, BC.

2.4. Macro-Level Components

Macro-level components directly influence the meso-level. These include: standards, governance, funding, and societal, political and economic trends [12]. **Standards** refers to "eHealth, organizational and professional practice standards" [12]. It should be noted that although professional practice standards may exist, it is important to evaluate their adoption at the meso-level (i.e., the aforementioned practice standardization construct). **Governance** is "the influence that governing bodies have on the organization and their attitudes towards [Health Information Technology]" [12]. Funding includes "the way the organization/project/individual receives funding" [12]. **Societal, political, and economic trends** refer to "public expectations, and the overall socio-political and economic climates toward technologies, eHealth and health care as a whole" [12].

2.5. Model Operationalization

To measure the EAU model constructs, over 130 metrics were identified at the health care organization, provider, patient, and population health levels. Corresponding instruments and methodologies to evaluate the metrics were also determined; they can be used for formative evaluation of any number of desired constructs.

3. Discussion & Conclusion

This paper contributes a conceptual model or "big picture" of the components of EHR adoption and use that are necessary to realize both quality and experience benefits. The EAU model is based on existing technology adoption/use theories in the information systems and health informatics literature. However, based on Island Health's EHR implementation experience, this model highlights a new benefit area (i.e., experience) for EHR benefits realization, as well as the addition of a meso-level construct (i.e., practice standardization). To the knowledge of the author, this is also the first model to (1) include the time dimension in benefits realization and (2) comprehensively include the multiple dimensions of the term "quality" in health care. The EAU model can be applied by decision-makers, practitioners, researchers, and evaluators to plan, implement, evaluate, and continuously improve EHR adoption and use for quality and efficiency benefits realization. Specifically, the implementation of this model highlights key causal relationships that may impact the intention and use of an EHR. As such, the model can be used to assess EHR readiness using instruments such as the UTAUT tool. Further, the moderating variables in the EAU model allow EHR project teams to develop customized end-user support to increase "Behavioral Intention" and "EHR Use Behaviour." Additionally, the relationship between "Facilitating Conditions" and "EHR Use Behaviour" suggests a need to invest in more post-implementation EHR education and training. The EAU model also emphasizes the time-sensitive nature of realizing some EHR benefits, which is helpful for implementation teams to communicate to end-users and decision-makers to ensure appropriate expectations shortly after Go Live. Additional research is needed to test this conceptual model to determine if it describes the reality of EHR adoption, use, and benefits realization. In particular, health care

organizations should evaluate the micro and meso levels of the model, as these tiers of the EAU model are highly influenced by organizational strategy and planning. It is recommended that national organizations such as Canada Health Infoway conduct an EHR evaluation at the macro-level to inform cross-national benefits evaluation evaluation efforts.

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