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Health Information Technology Evaluation Framework (HITREF) Comprehensiveness as Assessed in Electronic Point-of-Care Documentation Systems Evaluations

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Abstract

We assessed the Health Information Technology (HIT) Reference-based Evaluation Framework (HITREF) comprehensiveness in two HIT evaluations in settings different from that in which the HITREF was developed. Clinician satisfaction themes that emerged from clinician interviews in the home care and the hospital studies were compared to the framework components. Across both studies, respondents commented on 12 of the 20 HITREF components within 5 of the 6 HITREF concepts. No new components emerged that were missing from the HITREF providing evidence that the HITREF is a comprehensive framework. HITREF use in a range of HIT evaluations by researchers new to the HITREF demonstrates that it can be used as intended. Therefore, we continue to recommend the HITREF as a comprehensive, research-based HIT evaluation framework to increase the capacity of informatics evaluators' use of best practice and evidence-based practice to support the credibility of their findings for fulfilling the purpose of program evaluation.

Keywords:
Evaluation studies; Technology evaluation; Health information systems; Medical informatics.

Introduction

The increase in health information technology (HIT) implementation worldwide has created a need to better ensure the realization of the system's intended benefits using rigorous evaluation methods. Informatics evaluators tend to use frameworks, that is, models that describe the interrelationships among variables [1], describe the relationship between a framework dimension and a result [2, 3], or describe an implementation model [4]. However, most frameworks do not include the three contextual aspects – organizational, systemic and environmental (political), and professional – that influence whether or how the system will be used. Furthermore, frameworks with social and organizational evaluation dimensions lack clarity or specificity of their evaluation criteria, or have inadequate focus to assess both individual and organizational aspects of evaluation. For example the HOT-fit framework, which is theory-driven, does not include the professional contextual aspect [5].

To address the three-contextual-aspects deficit, the author (PS) developed and assessed the HIT Reference-based Evaluation Framework (HITREF) in the evaluation of an EHR implemented in a geriatric day care center[5, 6]. The framework included health services research evaluation methodologies to extend the informatics evaluators' focus beyond user, technical, and organization interactions to include organizational contextual considerations and other stakeholders' perspectives. The HITREF is a comprehensive HIT evaluation framework firmly grounded in research evidence that identifies a range of clinician satisfaction characteristics and dimensions to be measured. This framework was the result of a comprehensive literature review of over 2000 HIT evaluation studies [5] that expanded on the work of Ammenwerth and de Keizer who reviewed 15,000 articles [7]. The HITREF provides a comprehensive list of 22 criteria related to clinician satisfaction with HIT as themes for the study analyses, as shown in Figure 1. The criteria are organized along the following axes: Structure/Logistics/Process/Outcome with two additional concepts: *Barriers/Facilitators to Adoption* and *Unintended Consequences/Benefits*. Three components added the organizational context: Diffusion; HIT Selection/ Development/Implementation/Training; and Unintended Consequences/Benefits. Also Barriers/Facilitators to Adoption added systemic and environmental (political) contexts. Lastly, three components added the professional context (e.g., patient perspective): Patient Privacy; Patient Satisfaction with EHR; and Patient Satisfaction with Care [5].

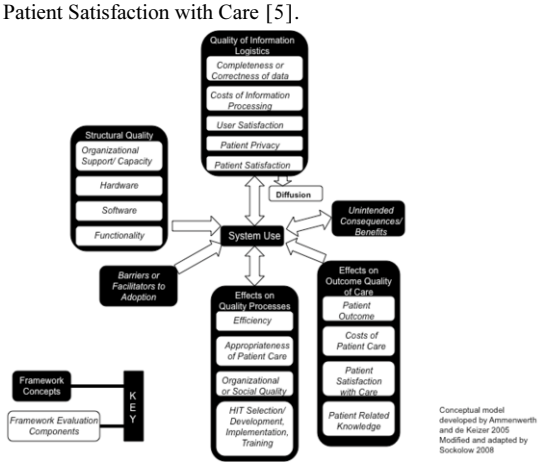

Figure 1 – The Health Information Technology Reference-based Evaluation Framework

This manuscript describes further assessment of HITREF comprehensiveness when used in evaluations of HITs in settings different from that in which the HITREF was originally developed. The new systems evaluated were point-of-care documentation systems used by health care professionals on multi-disciplinary teams who delivered direct patient care: a home care agency electronic health record (EHR) and a

hospital nursing information system (NIS).

Methods

To assess HITREF comprehensiveness, the clinician satisfaction themes that emerged from the home care and the hospital studies were compared to the framework. The home care study used an embedded mixed methods design to collect and analyze actual system usage, and post intervention clinician interviews and survey responses to assess satisfaction with the system [8]. The hospital study, carried out in two hospitals, employed scenario testing with qualitative analysis to assess clinician usage and satisfaction. The scenario study design was presented as a modified think-aloud protocol [9]. This protocol is a standard methodology used to elicit data about cognitive reasoning that occurs during a problem solving task. Twelve users were presented with typical usage scenarios and allowed to walk through how they would complete the action requested using the NIS [10]. Institutional Review Boards approved the studies.

Both the hospital and home care sites had implemented commercially available point-of-care documentation systems in which clinicians recorded care plans, interventions, and outcomes. The EHR was implemented in the home care site in 2009. It supported documentation management and had limited interoperability with health system hospitals. The study was conducted from 2008 to 2011 [8]. The hospitals implemented an NIS in 2011 that functioned with the Computerized Provider Order Entry system within the EHR. Nurses selected from the NIS's approximately 200 interdisciplinary evidence-based clinical practice guidelines to guide and document patient care. The NIS was evaluated in 2012 [10].

In the home care study (PS), semi-structured interviews were conducted until saturation eliciting information about clinicians' areas of concern or satisfaction with the EHR. Content analysis of interview responses started with the HITREF and was followed by mapping the coded themes to the framework, creating a conceptualization that encompassed all participants' experiences [8]. In the hospital study (KB,PS,MR), a convenience sample of consented nurses from selected floors participated in the scenario testing until saturation was reached. Satisfaction with NIS was assessed using scenario testing, which entailed the researchers' presenting to participants previously prepared scenarios and follow-up interview questions while observing their NIS use in a conference room on the unit. For each audio-recorded transcript, researchers coded themes independently and then coded together in relation to the HITREF. A 10% double reliability check was performed. Researchers retained any theme that did not match HITREF criteria (i.e., component within a larger HITREF concept) to add it to the framework as a new HITREF component. An unmatched theme was of special interest as it indicated an area where the framework was not comprehensive [10].

Results

Reported here are the results from both the home health agency and the hospitals studies related to HITREF comprehensiveness. The home health study included analysis of survey responses from 71 clinicians (52% of eligible participants) as well as observations and interviews with 6 (4%) clinicians [8]. The hospital NIS study involved 12 nurses on 2 units who participated in the scenario testing [10].

Home health clinicians were dissatisfied with initial and ongoing training and field support. They were satisfied with the hardware availability and dissatisfied with frequent system problems, as well as with EHR software related to usability and functionality. Overall clinicians were satisfied with the EHR data completeness and timeliness, which improved data availability and supported providing care and team communication. Some clinicians were dissatisfied with the unintended consequence of problems using the EHR, which negatively impacted patient care. Clinicians were also dissatisfied with EHR impact on efficiency resulting from a mismatch between the task requirements and the software functionality. While the EHR was observed to improve accessibility to clinical information, clinicians were dissatisfied with EHR impact on appropriateness of care. Clinicians perceived that the computer disrupted their establishment of patient rapport thereby impacting patient adherence. Clinicians were mostly satisfied with EHR impact on organizational/ social quality related to team communication. On the other hand, clinicians were particularly dissatisfied with their perceived lack of involvement in system selection/ development/ implementation/ training. Lastly, clinicians identified a barrier to adoption: inadequate interoperability as exemplified by their inability to access laboratory results from sources external to the health system [8].

In summary, home health clinicians commented on the following 12 HITREF components, organized within 5 *HITREF concepts* (examples are provided in Table 1):

- *Structural Quality*: Organizational support/capacity, Hardware (e.g., system availability [5]), Software (e.g., usability [5]), Functionality (e.g., tools and resources [5]);
- *Quality of Information Logistics*: Completeness/correctness of data (e.g., data quality [5]), User satisfaction;
- *Unintended Consequences* (e.g., benefits or adverse results [5]); and
- *Effects on Quality Processes*: Efficiency (e.g., time required for tasks [5]), Appropriateness of Patient Care (e.g., "medical efficiency" such as adherence to protocols [5]), Organizational or social quality (e.g., cooperation or communication [5]), HIT Selection/ Development/Implementation/Training; and
- *Barriers or Facilitators to Adoption* (e.g., perceptions related to implementations [5]).

The hospital NIS study findings indicated that the participating nurses universally preferred documenting in the NIS rather than return to paper records. As seen in the home health study, hospital nurses were dissatisfied with the ongoing HIT training as well as software usability and functionality. They were dissatisfied with computer placement, which required standing while using the computer. Also as seen in the home health study, nurses were satisfied with the completeness and timeliness of the documentation. Nurses were dissatisfied with the changes introduced by the NIS, which included redundant documentation and bottlenecks, thereby reducing efficiency. They were also dissatisfied with NIS impact on appropriateness of care related to increased time at the bedside documenting and decreased time spent providing direct patient care. Related to Organizational/social quality, the potential to realize team communication among the clinical roles and disciplines was not always realized as evidenced by duplicate documentation and redundant questions posed to the patient [10].

The hospital nurses commented on the following 8 HITREF components within 3 *HITREF concepts*:

- *Structural Quality*: Organizational support/capacity, Hardware, Software;
- *Quality of Information Logistics*: Completeness/correctness of data, User satisfaction; and

- *Effects on Quality Processes*: Efficiency, Appropriateness of Patient Care, Organizational/social quality (team communication).

Across both studies, respondents commented on 12 HITREF components across 5 HITREF concepts. All themes that emerged from either study matched a HITREF component.

Table 1 - Examples of HITREF Concepts/Components Occurring in Each Study

HITREF Concept	**HITREF Component**	**Home Care**	**Hospital**
Structural Quality	Organizational Support/capacity	-Field Support, Training	- Training; Communication
	Hardware	- Reliability	- Computer placement
	Software	- Usability: Navigation	- Usability: Navigation; Mismatch screenflow/ workflow; Documentation fatigue
	Functionality	+Memory prompts	-Absence of needed functionality
Quality of Information Logistics	Completeness/ correctness of data	+ Timely, complete	+ Accessible, Complete
	Costs of information processing	NA	NA
	User satisfaction	+Overall satisfaction	+Overall satisfaction
	Patient privacy	NA	NA
	Patient satisfaction with EHR	NA	NA
	Diffusion	NA	NA
Unintended Consequences/Benefits	Unintended Consequences/Benefits	- EHR problems interfere with patient care	NA
Effects on Outcome Quality of Care	Patient outcome	NA	NA
	Costs of patient care	NA	NA
	Patient satisfaction with care	NA	NA
	Patient related knowledge	NA	NA
Effects on Quality Processes	Efficiency	- Increased documentation	- Bottlenecks; Redundant documentation; Many checkboxes
	Appropriateness of patient care	-Patient rapport	+ Time at bedside - Patient time, more NIS time
	Organizational or social quality	+Team communication	-Potential for increased multidisciplinary team communication not realized
	HIT Selection/ Development/ Implementation/ Training	- Clinician involvement	NA
Barriers or Facilitators to Adoption	Barriers or Facilitators to Adoption	- Interoperability	NA

Note: + indicates satisfactory attributes; - indicates dissatisfactory attributes; NA indicates not applicable

Discussion

The HITREF was designed to be used to evaluate a broad range of HIT. To date, the framework has been used to assess two types of HIT in three different settings, [6, 8, 10]. In addition to being evidence-based, a HITREF advantage is the inclusion of organizational, systematic and environmental, and professional criteria to evaluate whether the HIT was used as intended [5]. Across the two evaluations described in this manuscript, [8, 10] these three levels of criteria had one or more components with matched themes (e.g., Organizational support/capacity, Barriers/facilitators to adoption, User satisfaction, respectively). The emergence of these themes underscores the HITREF's value as an evaluation tool that includes contextual concerns in addition to technological capabilities. The initial study in which the HITREF was assessed [5] and the two studies described in this manuscript [8, 10] were similar in the inclusion and exclusion of HITREF components in the evaluations, despite differences in settings and HIT evaluated. The absence of new components missing from the HITREF indicates that the HITREF is a comprehensive evaluation framework.

Overall, 60% of the HITREF components emerged in the two recent studies across all but one of the HITREF concepts, as shown in Table 1. The excluded concept, *Effects on Outcome Quality of Care*, contains four patient-focused components without related themes that emerged in the evaluations. The constituent component, Costs of patient care, is an issue not usually encountered by front line clinicians. Two components that address the patient perspective (i.e., Patient satisfaction with care; Patient related knowledge) may be more likely to emerge in evaluations of patient-facing systems such as personal health records, EHR patient portals, or mobile health applications. Notable is the presence of patient outcomes in this group of unmatched components. Possibly clinicians did not see a relationship between their use of the point-of-care documentation system and the organization's goal of system implementation to improve patient outcomes. Similarly, the component Diffusion in the *Quality of Information Logistics* concept has a focus on an issue not usually encountered by front line clinicians: whether the system is universally used. Two additional components in the *Effects on Outcome Quality of Care* concept that addressed the patient perspective (i.e., Patient privacy concerns; Patient satisfaction with EHR) did not have themes emerge, probably because the studies did not assess patient-facing systems.

The 60% component match and lack of new components support the applicability of HITREF in evaluations with a range of HIT, settings, and users. Although the framework was

drawn from literature mostly focused on physician HIT use in hospitals [5, 7], the studies involved nurses in hospitals and multi-disciplinary teams in community settings, and focused on both EHRs and NIS. However, it is possible that HITREF use in evaluations of other HIT may identify new components to be added to the HITREF.

The two evaluations also provided support for another aspect of HITREF applicability: its use by informatics evaluators. While the first author (PS) developed the HITREF and conducted the studies, other members of the research team (KB, MR) successfully used the HITREF in their analyses (8, 10]. Use by informatics researchers other than the HITREF developer is evidence that the HITREF belongs in informatics evaluators' toolboxes.

As suggested in our initial study, because the HITREF is relatively large, the evaluator may choose to select HITREF components related to the questions being asked. For example, an evaluator could include questions about patient care and efficiency in evaluations of HIT intended to improve the clinical process or exclude questions about patient perspective from a point-of-care documentation system study.

A research opportunity previously identified that is yet to be addressed is increased knowledge about the relationships among the HITREF evaluation components. This exploration will be possible by using the HITREF in evaluation studies of larger sample sizes.

Conclusion

The HITREF fulfills the purpose of a framework: to ensure a study is comprehensive in terms of inclusion of stakeholder concerns to promote engagement and obtaining full information, and improve decision-making. HITREF use in evaluations with a range of HIT, settings, and users, by researchers new to the HITREF, demonstrates that it can be used as intended. Therefore, we continue to recommend the HITREF as a comprehensive, research-based HIT evaluation framework to increase the capacity of informatics evaluators' use of best practice and evidence-based practice to support the credibility of their findings for fulfilling the purpose of program evaluation.

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